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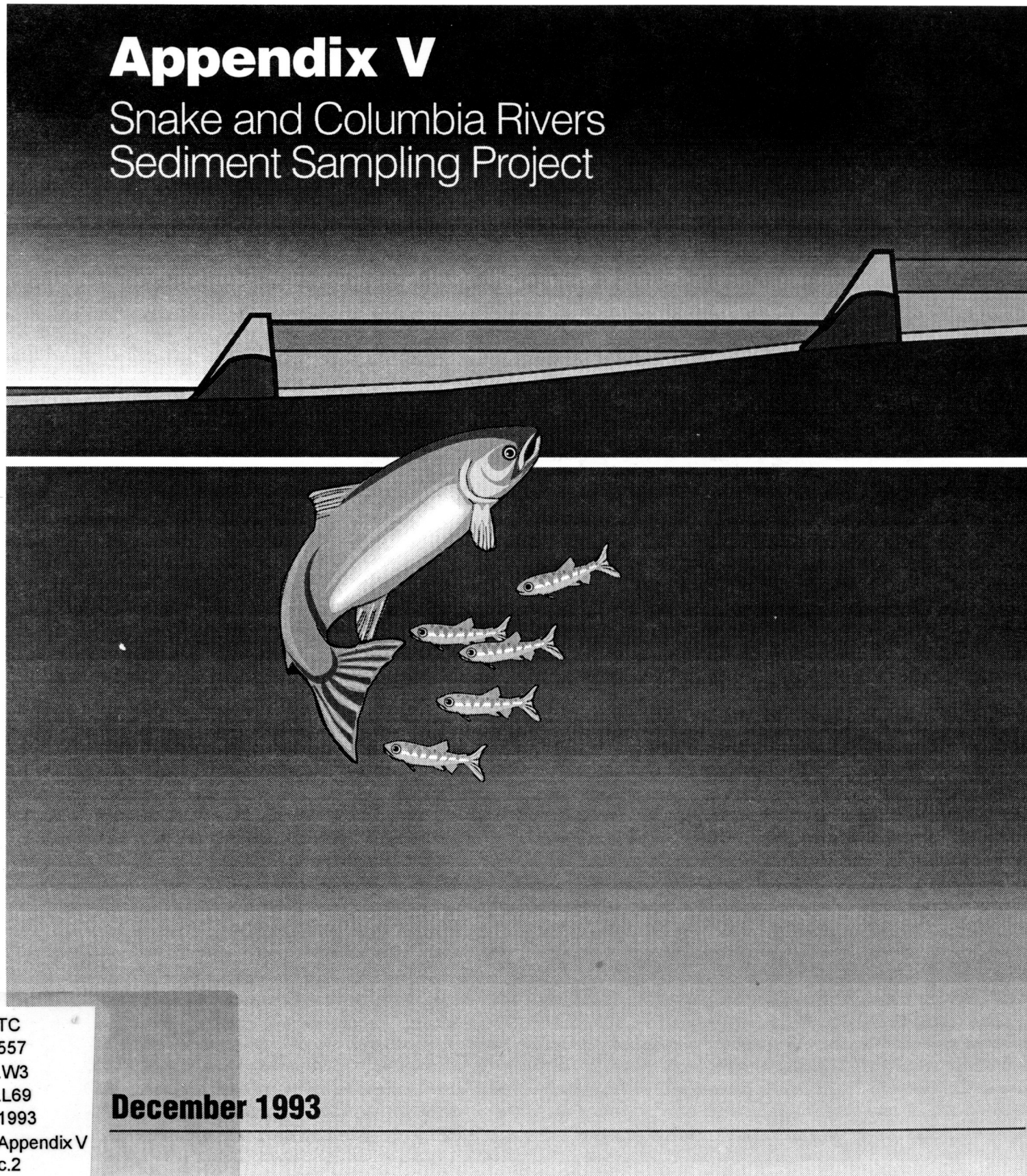
Walla Walla District

1992 Reservoir Drawdown Test

Lower Granite and Little Goose Dams

Appendix V

Snake and Columbia Rivers
Sediment Sampling Project



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Snake and Columbia Rivers Sediment Sampling Project

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Sequim, Washington**

December 1992

**Prepared for
U.S. Army Corps of Engineers - Walla Walla District
under a Related Services Agreement
with the U.S. Department of Energy
Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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**SNAKE AND COLUMBIA RIVERS SEDIMENT
SAMPLING PROJECT**

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Richland, Washington 99352

SUMMARY

Columbia River Basin salmon stocks have declined in part as a result of human development. Historical estimates suggest that as many as 11 to 16 million adult salmon annually returned to the mouth of the Columbia River. Current estimates suggest that about 2.5 million adult salmon are produced in the rivers, of which 80% are hatchery stock. One measure being proposed to assist in the rebuilding of these declining stocks is to lower the water level of the reservoirs behind the mainstem dams on the Snake River and selected Columbia River dams. The goal of the drawdown is to decrease water particle travel time by forcing the same amount of water through a smaller cross-sectional area of the reservoir. This increase in velocity could potentially reduce the time that the juvenile salmon spend migrating downriver and increase their chances for survival. In 1991 and 1992, the Snake River reservoirs will be operated at their minimum operating level. More substantial drawdowns are proposed for the future.

It is unclear if reservoir drawdowns will result in overall increased survival for downstream salmon migrants. In addition to this uncertainty, reservoir drawdown results in several problems. Commerce along the river depends on ship and barge access to terminals and piers. By lowering the reservoir levels to minimum operating pools, the depth of water at these terminals and piers is decreased, which may then necessitate dredging to maintain navigation depth requirements. Dredging activity requires sediment disposal in one or more of the following ways: in the river, along the shorelines, or at upland sites, contingent upon contaminant loads within the dredged sediment. Drafting the pool to levels substantially below minimum operating pools will also result in resuspension of fine-grained reservoir sediments from newly exposed shorelines on which material has been deposited since the projects were built. This increase in suspended sediment may be harmful to water quality and also juvenile and adult salmon. A test of the reservoir drawdown concept (below normal operating levels) using Lower Granite and Little Goose reservoirs will be conducted in 1992.

The disposal of dredged material in water is defined as a discharge under Section 404 of the Clean Water Act and must be evaluated in accordance with U.S. Environmental Protection Agency regulation 40 CFR 230. Because contaminant loads in the dredged sediment or resuspended sediment may affect water quality or contaminant loading, the U.S. Army Corps of Engineers (USACE), Walla Walla District, has requested Battelle/Marine Sciences Laboratory (MSL) to collect and chemically analyze sediment samples from areas that may be dredged near the Port Authority piers on the Snake and Columbia rivers. Sediment samples were also collected at River Mile (RM) stations along the Snake River that may undergo resuspension of sediment as a result of the drawdown. Chemical analysis included grain size, total organic carbon, total volatile solids, ammonia, phosphorus, sulfides, oil and grease, total petroleum

hydrocarbons, metals, polynuclear aromatic hydrocarbons, pesticides, polychlorinated biphenyls, and 21 congeners of polychlorinated dibenzodioxins and dibenzofurans.

Sediment samples were collected with a Van Veen grab or core sampler from potential dredging areas surrounding the Ports of Kennewick, Boise Cascade, and the Walla Walla Grain Growers Terminal on the Columbia River and the Ports of Almota, Burbank, Wilma, Lewiston, Clarkston, and the Sheffler Grain Terminal on the Snake River. From these ports or terminals, six stations on the Columbia River and 24 stations on the Snake River were sampled and composited into 13 analytical composites to evaluate sediment chemistry. The results of chemical analysis from seven sediment composites (Ports of Clarkston, Wilma, Lewiston, and Almota) were compared to sediments at a proposed disposal site at RM 119.56. This disposal site is approximately 13 miles upstream of the Lower Granite Reservoir and has been studied in a long-term program that monitors the effects of in-water disposal of dredged material on anadromous and resident fish populations.

Comparison of the concentrations of chemicals of concern were made between seven sediment composites at the ports and terminals and the proposed disposal site at RM 119.56. First, chemical concentrations at each sampling station were compared with those at RM 119.56, noting those composites with chemical concentrations elevated above those at RM 119.56. Second, following the guidelines set forth by USACE, sediment composites with concentrations greater than 1.5 times the concentrations at RM 119.56 were also discussed and summarized. This comparison showed that sediments from the following ports or terminals had chemical concentrations below those at RM 119.56, Port of Wilma (SRP 14 through 22), Port of Clarkston (SRP 24,25), Port of Lewiston (SRP 28,29), Port of Almota (SRP 55,56)

Port or terminal sediment composites with elevated levels in excess of 1.5 times those at RM 119.56 included Port of Kennewick (SRP 3,4) with elevated metals (Cd, Pb, and Zn) and PAH compounds; Port of Clarkston (SRP 24,25) with elevated concentrations of some PAH compounds; and the Port of Lewiston (SRP 30 through 32, and SRP 33,34) with elevated concentrations of some of the PAH compounds.

River Mile 119.56 was also used as a background site for the other RM stations in this study. A background sample from a proposed disposal site on the Columbia River or near the mouth of the Snake River was not collected because dredged material from these areas was scheduled for disposal at an uplands site where there would be no potential return of material to the river. Consequently the discussions and conclusions from the Ports of Burbank, Kennewick, Walla Walla Grain Terminal, and Boise Cascade Mill focus on general relationships between the chemical parameters analyzed in this study.

Six stations, referred to as RM stations, were sampled and analyzed for possible contamination. Locations of these RM stations were chosen based on a 1991 study done by MSL, which determined that they contained fine-grained sediment that could be resuspended as a result of wind, wave, and precipitation during the proposed 1992 drawdown test. These RM stations were located between RM 119.56 and 131.62, approximately 12 miles upstream of the Lower Granite Dam (RM 107.5). Two core or grab samples were collected from each of the six stations. The samples from each station were individually composited, producing six separate samples that were submitted for chemical analysis. The discussions and conclusions from these six RM composites also focus on general relationships between the chemical parameters analyzed in this study.

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1.0 INTRODUCTION

Columbia River Basin salmon stocks have declined in part as a result of human development. Historical estimates suggest as many as 11 to 16 million adult salmon annually returned to the mouth of the Columbia River. Current estimates suggest that about 2.5 million adult salmon are produced in the rivers that drain into the Columbia River Basin, of which 80% are hatchery stock. One measure being proposed to assist in the rebuilding of these declining stocks is to lower the water level of the reservoirs behind the mainstem dams on the Snake River and selected dams on the Columbia River. The U.S. Army Corps of Engineers (USACE), Walla Walla District, requested Battelle/Marine Sciences Laboratory (MSL)^(a) to chemically evaluate the following: 1) sediment that may be dredged from port areas to allow continued operation at minimum operating pools, and 2) Snake River reservoir sediments that could potentially become exposed and/or resuspended during more substantial drawdowns.

The goal of the drawdown is to decrease downstream travel time for juvenile salmon by increasing river velocity. The increased velocity is achieved through forcing the same amount of water through a smaller cross-sectional area of the reservoir. The resulting increased water velocity associated with the drawdown is expected to reduce travel time of juvenile salmon from rivers to the open ocean and potentially increase their survival. The Columbia Basin Fish and Wildlife Authority recommends a minimum flow of 140,000 cubic feet per second (cfs) as the optimum target in the lower Snake River. Because the recommended minimum flow is not considered achievable during a low flow year using water from storage projects, reservoir drawdown is being considered as a way of achieving equivalent velocities.

Two separate issues spurred this sediment evaluation work. First, the lower Snake and selected Columbia reservoirs are being operated at the low end of their range in 1991 and 1992 (and potentially in upcoming years as well) to reduce juvenile salmon travel time and minimize the effects to project features such as navigation and irrigation. However, port areas on the lower Snake and Columbia Rivers require dredging to insure minimum navigation depth while the pools are maintained at these lower levels (in the past, the pools have most frequently been operated in the middle of their 3- to 5-ft operating ranges). Dredged material is proposed for disposal in-water, contingent upon Section 404 (Clean Water Act) review.

The second issue is that of the proposed long-term operation, which includes drafting the reservoirs on the lower Snake River 30 to 50 ft to achieve velocities equivalent to 140,000 cfs. This type of operation would expose sediments that have accumulated over time to wind,

(a) The Battelle/Marine Sciences Laboratory is part of the Pacific Northwest Laboratory, which is operated for the U.S. Department of Energy by Battelle Memorial Institute.

waves, and precipitation. There is concern that resuspension of potentially contaminated sediments would degrade water quality and be harmful to anadromous fish as well as other aquatic organisms.

Sediment samples were collected and chemically analyzed from ports and terminals on the Columbia and Snake rivers in accordance with Section 404 of the Clean Water Act and U.S. Environmental Protection Agency (EPA) regulations 40 CFR 230. The ports and terminals on the Columbia River include the Port of Kennewick and the terminals of Walla Walla Grain Growers and the Boise Cascade mill. The ports and terminals on the Snake River include the Ports of Almota, Burbank, Wilma, Clarkston, and Lewiston, and the Sheffler Grain terminal (Figure 1.1). Six stations were sampled at ports on the Columbia River and 24 stations were sampled at ports on the Snake River (Table 1.1) These stations were combined into 13 sediment composites that were submitted for chemical analyses.

Six stations referred to in the text as River Mile (RM) stations, were sampled in the Lower Granite Reservoir (SRP 12, 13, 23, 52, 53, and 54) to provide information on the potential for sediment toxicity associated with resuspension during drawdown (Note: all stations carry the SRP prefix, which stands for Snake River Project). The six sampling stations extended from RM 119.36 to RM 131.62, and were chosen jointly by USACE and MSL personnel based on river channel morphology and previous sediment sampling experience. The core or grab samples from each RM station were combined to form six sediment composites that were submitted for chemical analysis. The potential drawdown may affect all the lower Snake River reservoirs; however, drawdown of the Lower Granite reservoir is of most concern because sediment deposits in the pool of this reservoir will be the first affected by the drawdown.

Sediments were collected with either a Van Veen grab or a 4-in. vibratory-hammer coring device. The 4-in. coring device was specially designed by MSL for this study and was equipped with a valve that closes upon impact with hard substrate, preventing loss of sediment. Samples were taken to the full depth of sediment at each reservoir station (approximately 3 to 7 ft). Specific locations of each sampling station are presented in Figures 1.2 through 1.11.

Sediment from each sampling station (both port stations and RM stations) was mixed to produce a total of 19 sediment composites (13 port or terminal composites and 6 RM composites) that were submitted for chemical evaluation. Analysis included grain size, total organic carbon (TOC), total volatile solids (TVS), ammonia, phosphorus, sulfides, oil and grease, total petroleum hydrocarbons (TPH), metals, polynuclear aromatic hydrocarbons (PAH), pesticides, polychlorinated biphenyls (PCB) and 21 congeners of polychlorinated dibenzo dioxins and dibenzo furans (PCDD/PCDF).

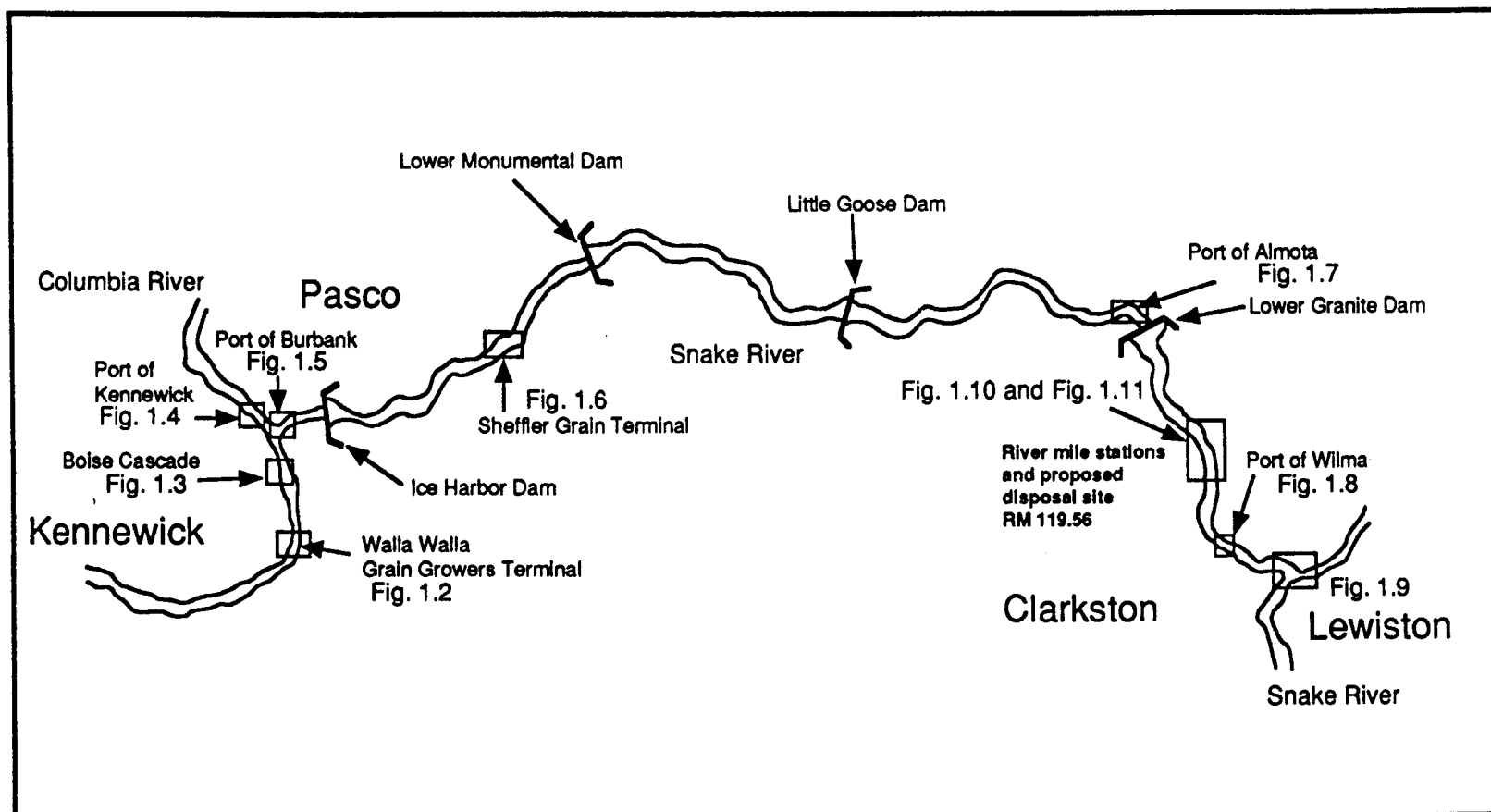


FIGURE 1.1. Map of Study Area Indicating Sampling Stations

TABLE 1.1. Columbia and Snake Rivers Sampling Station Information

<u>Sampling Station</u>	<u>Replicate</u>	<u>Date</u>	<u>Water Depth</u>	<u>Core Length</u>	<u>Comments</u>
<u>Columbia River Sampling Stations</u>					
SRP 1	1	8/19/91	14'	4'7"	Sandy sediment; some fines
SRP 2	1	8/19/91	11'	5'4"	
SRP 3	1	8/20/91	20'	3'0"	Light brown clay silt under sand
SRP 4	1	8/20/91	17'	1'8"	Gravelly sand
SRP 50	1	8/19/91	11'	4'6"	Course sand at base of core under fine organic matter
SRP 51	1	8/19/91	11'	4'8"	Gravel at base of core under fine sediments
<u>SNAKE RIVER SAMPLING STATIONS</u>					
SRP 7A	1	8/19/91	7'	5'5"	
SRP 9	1	8/20/91	40'	0'4"	
1.4 SRP 12(a)	1	8/23/91	18'	5'6"	Dark brown sandy silt; brown silty sand
	2	8/23/91	18'	4'2"	Predominantly dark brown sandy silt
SRP 13(a)	1	8/23/91	18'	8'7"	Top of core dark brown silty sand
	2	8/23/91	18'	9'1"	Dark brown silty sand
SRP 14	1	8/22/91	24'	10'0"	
SRP 15A	1	8/22/91	26'	1'5"	Silty sand
	2	8/22/91	26'	5'3"	
SRP 16	1	8/22/91	39'	1'0"	Silt and sand
	2	8/22/91	39'	2'0"	

TABLE 1.1. (contd)

<u>Sampling Station</u>	<u>Replicate</u>	<u>Date</u>	<u>Water Depth</u>	<u>Core Length</u>	<u>Comments</u>
SRP 17	1	8/22/91	33'	4'3"	Gravel at base of core under silty sand
SRP 18	1	8/22/91	28'	4'5"	Gravel at base of core under silty sand
SRP 19	1	8/22/91	29'	1'8"	Gravel at base of core under silty sand
	2	8/22/91	29'	4'8"	Dead carp observed in water near site
SRP 20	1	8/22/91	34'	1'0"	Sand and silt
SRP 21	1	8/22/91	30'	1'5"	
SRP 22	1	8/22/91	22'	7'5"	Brown silty fine sand over gravel with wood chips on top
SRP 23(a)	1	8/23/91	12'	2'0"	Dark brown silty sand/sandy silt
SRP 24	1	8/22/91	20'	4'2"	Bottom of core medium sand
SRP 25	1	8/22/91	19'	3'7"	
SRP 26	1	8/22/91	22'	2'4"	Fine and medium sand
SRP 27	1	8/22/91	22'	3'2"	
SRP 28	1	8/22/91	25'	2'0"	
SRP 29	1	8/22/91	21'	3'6"	Sand and gravel with rocks in the bottom
SRP 30	1	8/22/91	20'	1'5"	
	2	8/22/91	20'	Bag	Cutterhead material shipped in bag

TABLE 1.1. (contd)

<u>Sampling Station</u>	<u>Replicate</u>	<u>Date</u>	<u>Water Depth</u>	<u>Core Length</u>	<u>Comments</u>
SRP 31	1	8/22/91	19'	1'5"	Cutterhead material kept with sample
	2	8/22/91	19'	1'5"	Sandy sediment with rocks
SRP 32	1	8/22/91	18'	1'3"	Sandy sediment
	2	8/22/91	18'	1'5"	Sand and gravel with rocks on bottom
SRP 33	1	8/23/91	12'	4'9"	Medium sand with cobbles at base of core
SRP 34	1	8/23/91	12'	1'0"	Medium and fine sand
	2	8/23/91	12'	3'0"	Gravel at base of core
SRP 52(a)	1	8/24/91	20'	NA(b)	Van Veen grab used; dark brown sandy silt
SRP 53(a)	1	8.24.91	18'	NA	Van Veen grab used; dark brown sandy silt
SRP 54(a)	1	8/24/91	17'	NA	Van Veen grab used; dark brown sandy silt
SRP 55	1	8/24/91	20'	NA	Van Veen grab used; medium & fine sand
SRP 56	1	8/24/91	1'	NA	Van Veen grab used; medium sand, few cobbles

(a) River Mile stations in the Lower Granite Reservoir.

(b) NA Not applicable.

The chemistry results of seven sediment composites from the Ports of Wilma, Clarkston, Lewiston, and Almota were then compared to chemical analysis of sediments from RM 119.56 which is the proposed in-water disposal site for dredged material from these ports. This in-water disposal site is approximately 13 river miles upstream from Lower Granite Dam.

At the time of this project, dredged material from the Port of Burbank down to Walla Walla Grain Growers Terminal (which includes Sheffler Grain Terminal, Port of Kennewick, and the Boise Cascade Mill) was not anticipated for in-water disposal; consequently, sediment chemistry results from the six composites representing these ports or terminals are not compared to results from a disposal site.

The RM stations are not part of the potential dredging area and will not be compared to the proposed disposal site.

The comparison of the Snake River composites (Ports of Wilma, Clarkston, Lewiston, and Almota) provided USACE with information to determine if dredged material might have an adverse impact and cause degradation of sediment quality at the proposed disposal site. The criteria for acceptability of in-water disposal indicates that the dredged material must have better than or equal sediment quality to the proposed disposal site. If this occurs, then the dredged material will not adversely impact the disposal site and the material is suitable for in-water disposal. However, if the dredged material is significantly more contaminated than the disposal material, in-water disposal is not an option and an alternative method will need to be identified.

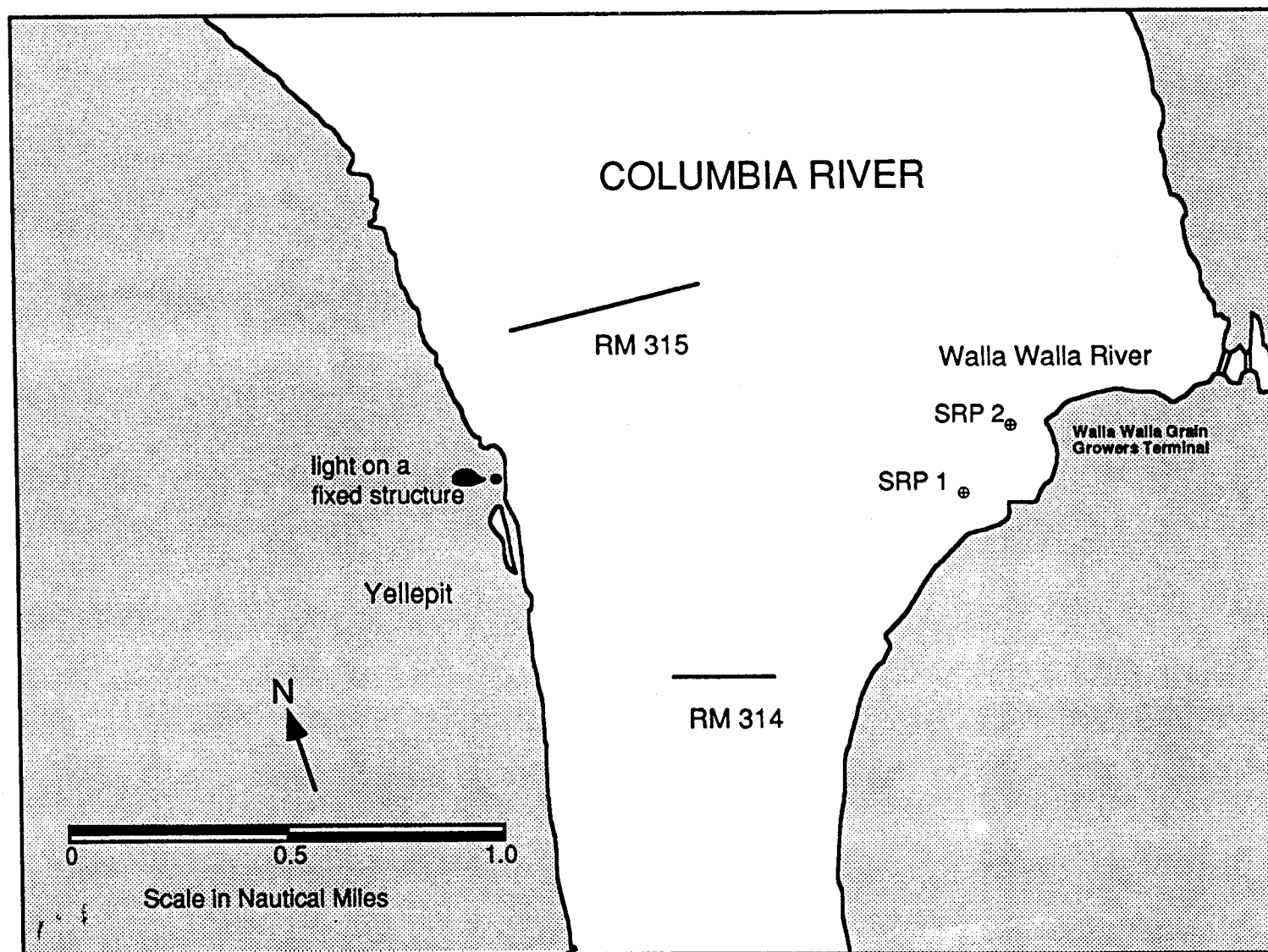


FIGURE 1.2. Sampling Stations at the Walla Walla Grain Terminal

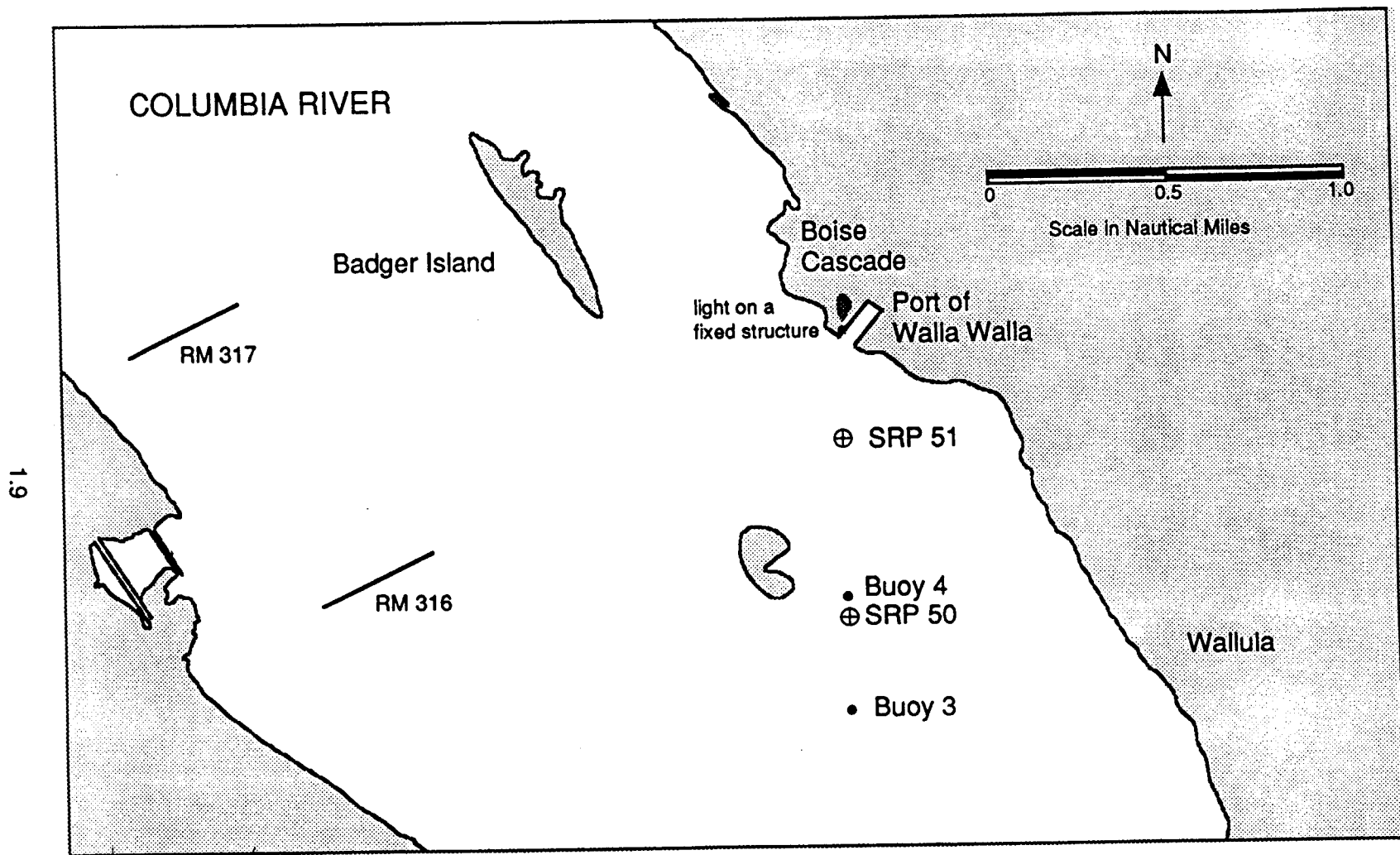


FIGURE 1.3. Sampling Stations at the Boise Cascade Mill

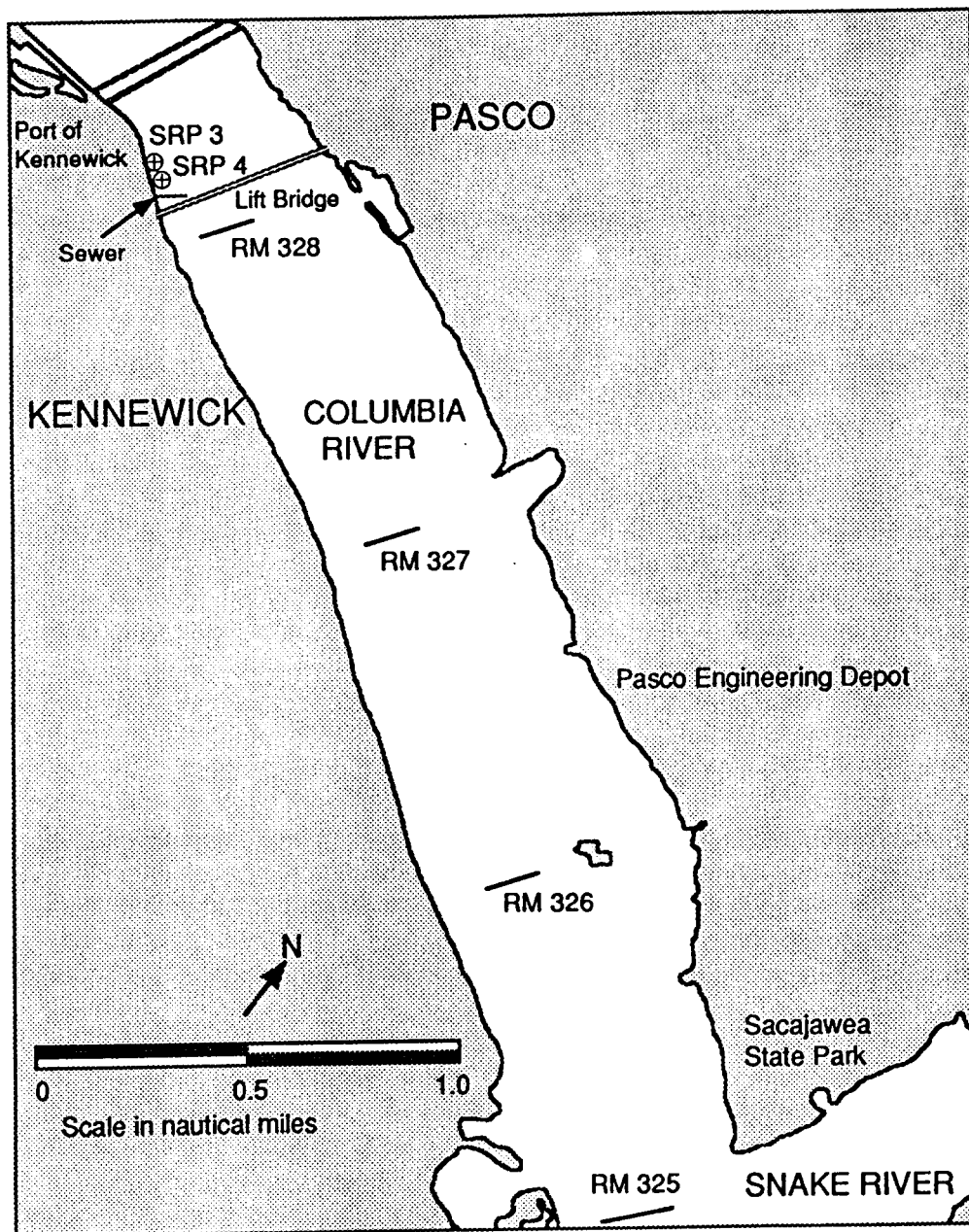


FIGURE 1.4. Sampling Stations for the Port of Kennewick

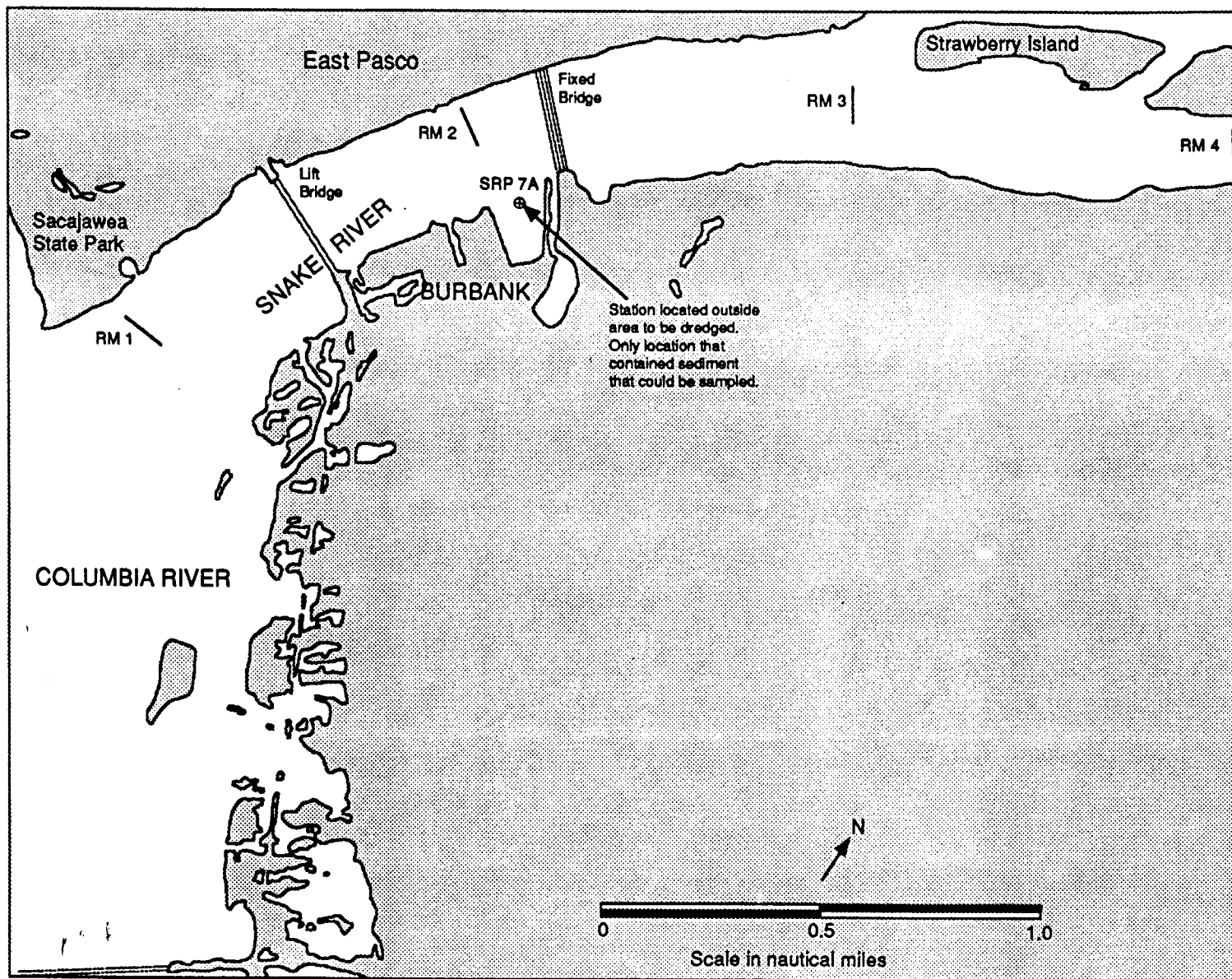


FIGURE 1.5. Sampling Stations at the Port of Burbank

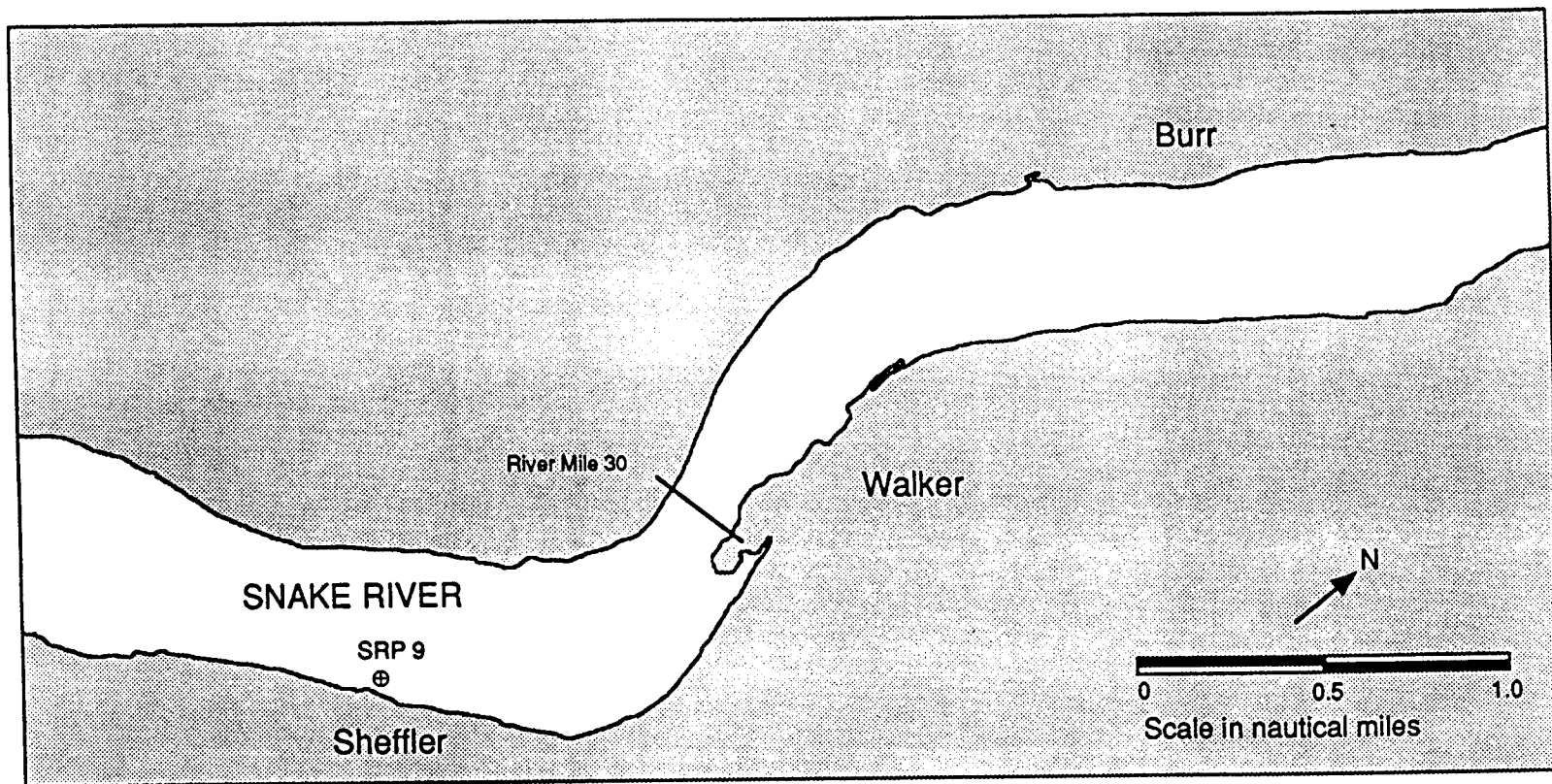


FIGURE 1.6. Sampling Station at the Sheffler Grain Terminal

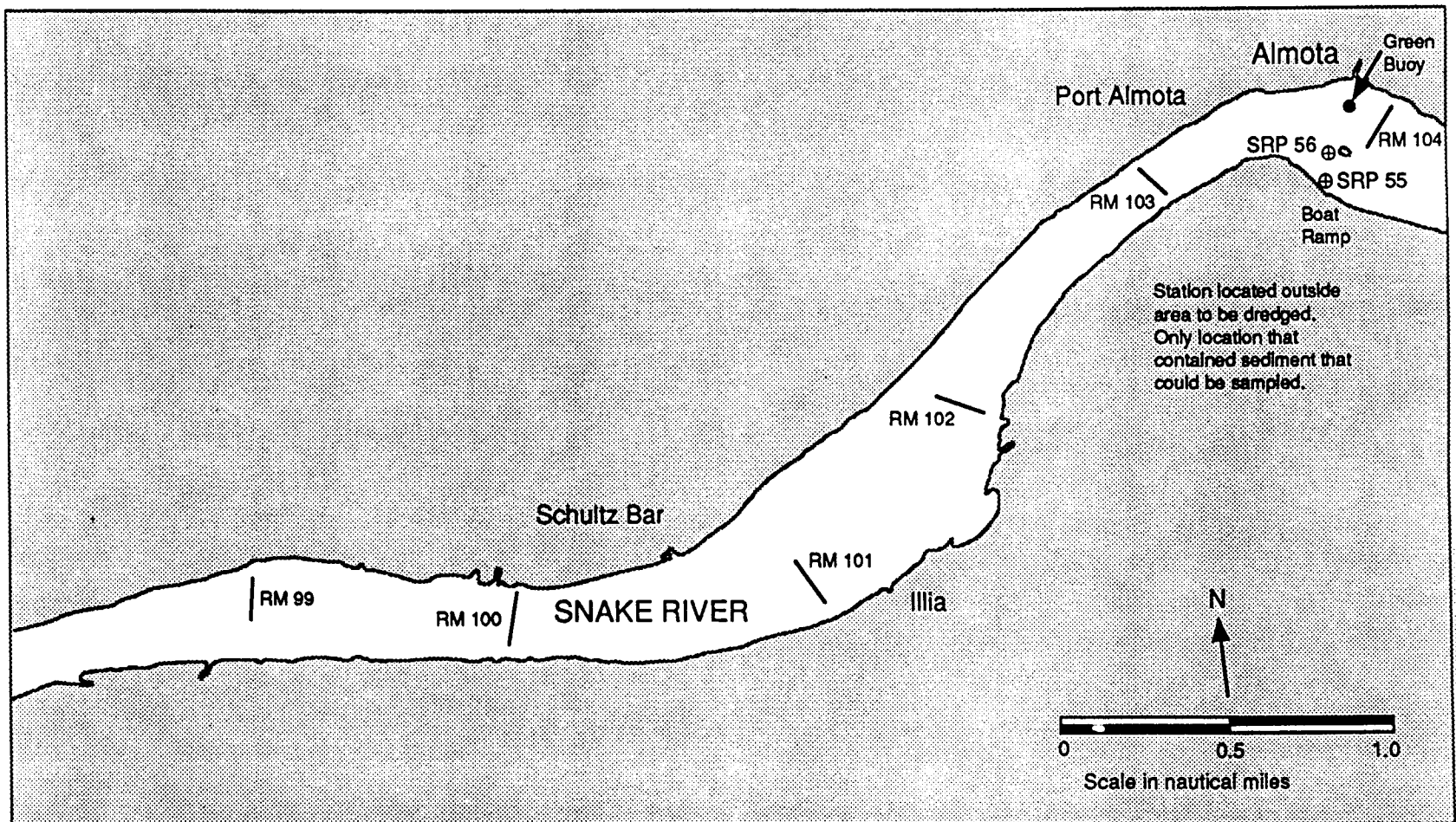


FIGURE 1.7. Sampling Stations at the Port of Almota

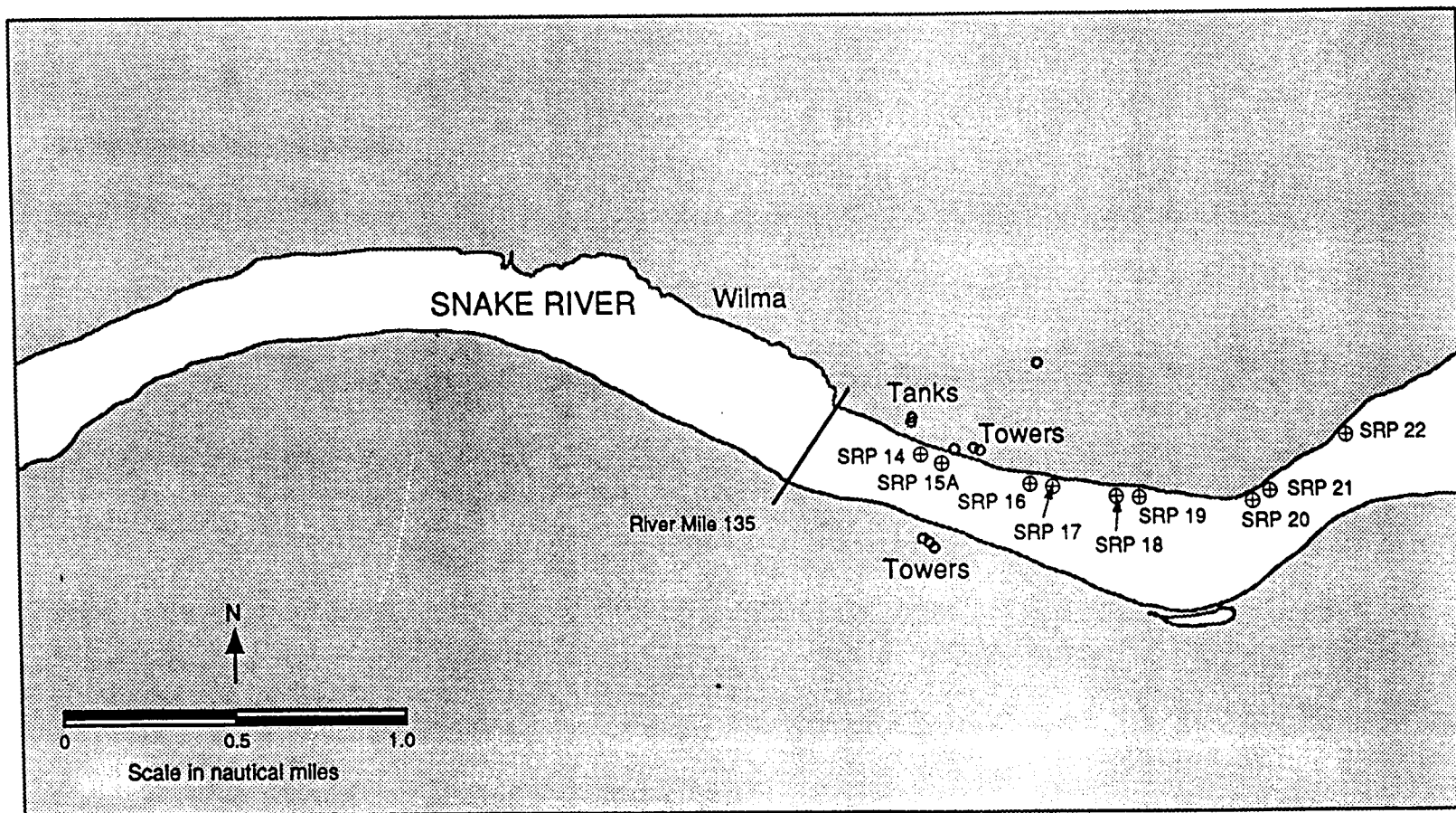


FIGURE 1.8. Sampling Stations at the Port of Wilma

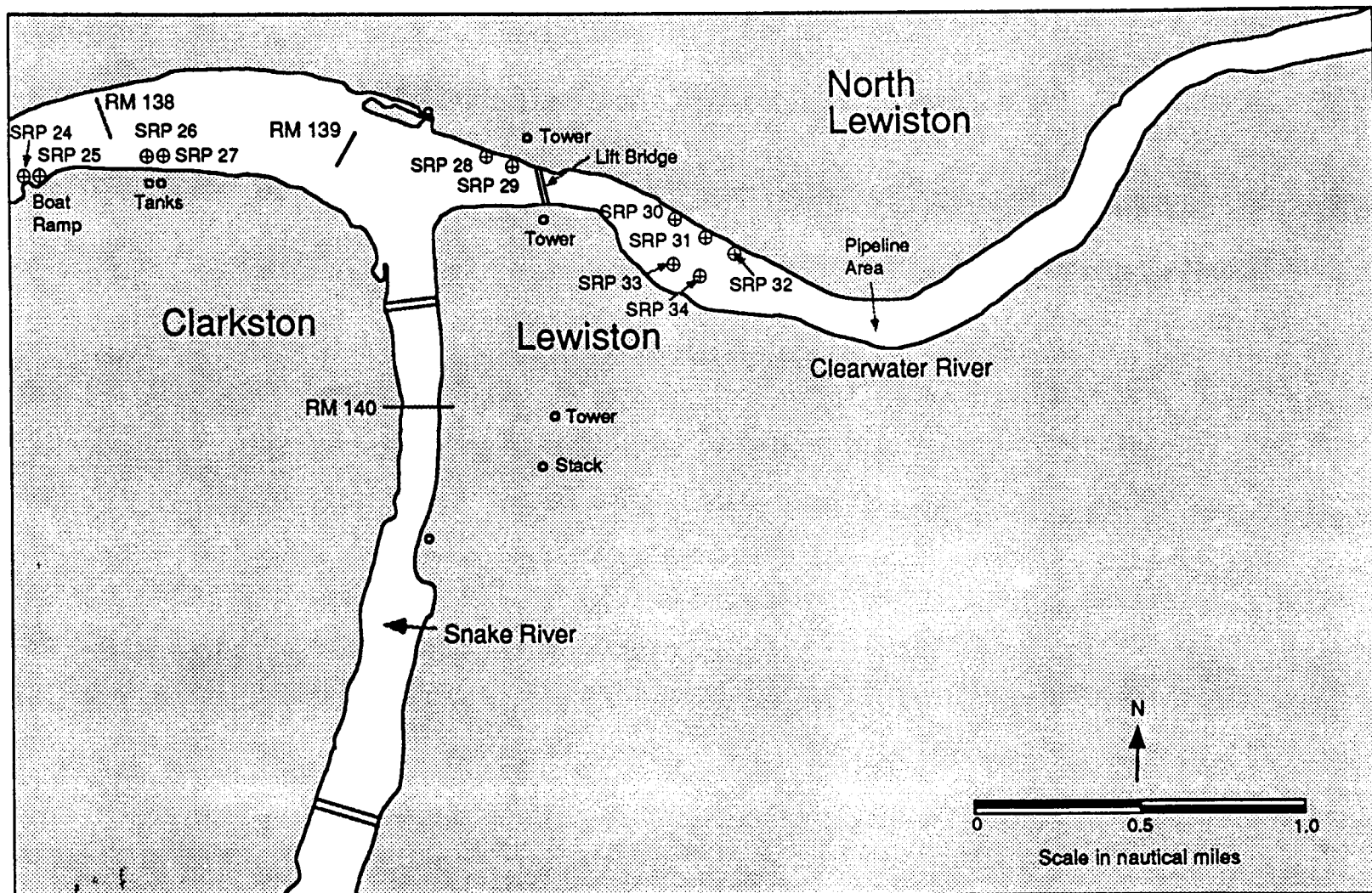


FIGURE 1.9. Sampling Stations at the Ports of Clarkston and Lewiston

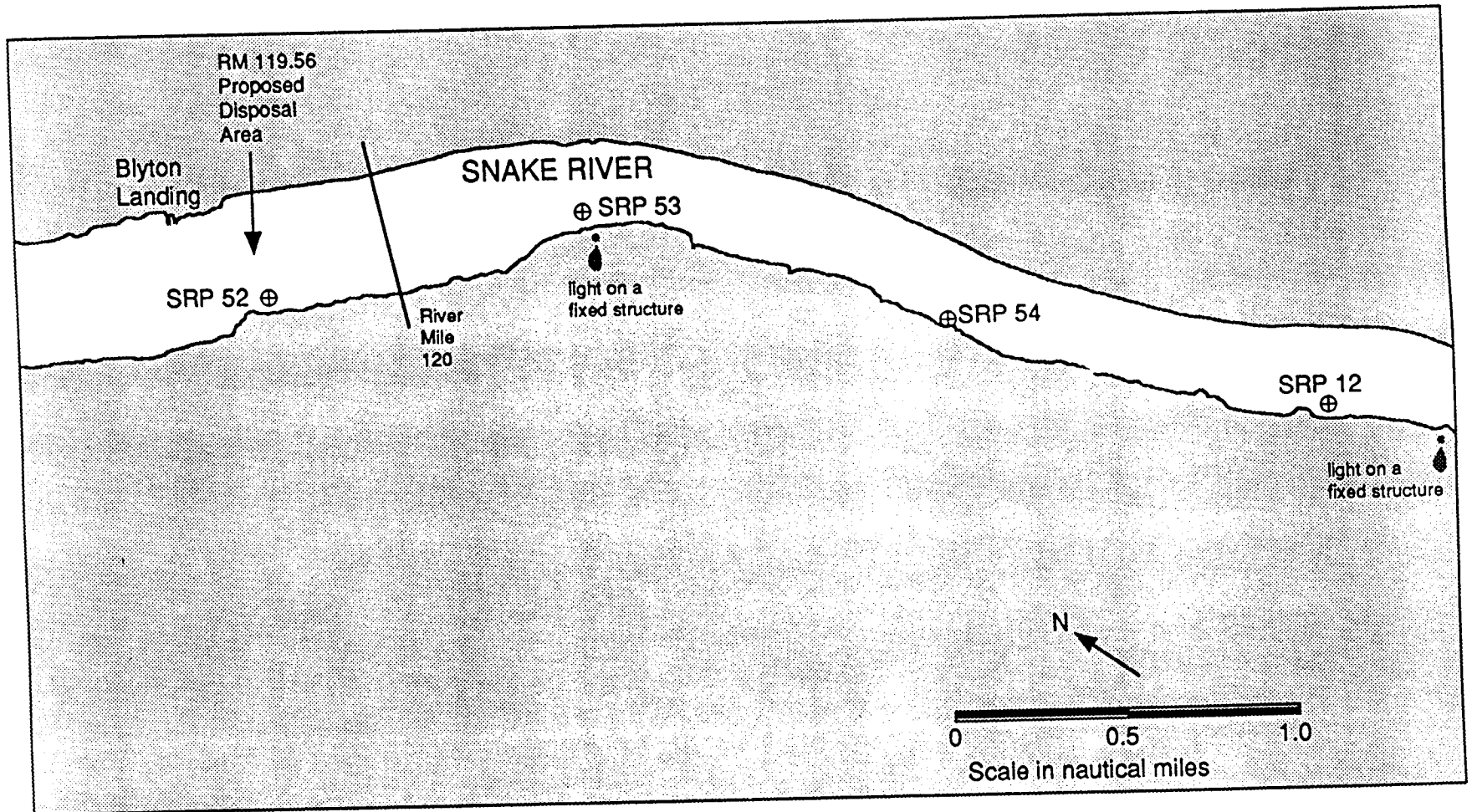


FIGURE 1.10. River Mile Stations SRP-12, SRP-52, SRP-53, and SRP-54

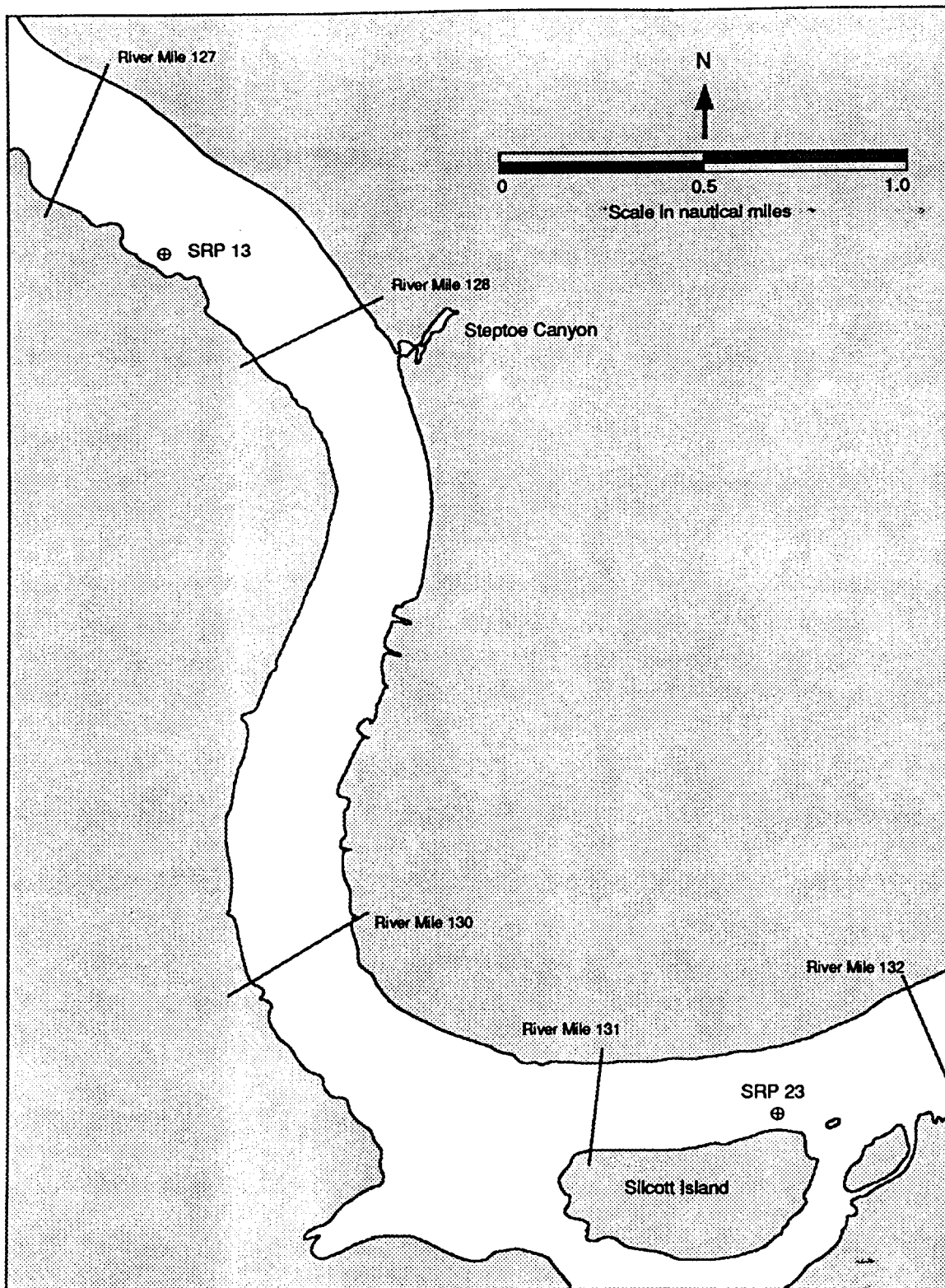


FIGURE 1.11. River Mile Stations SRP-13 and SRP-23

2.0 METHODS

2.1 FIELD SAMPLING

Sediment sampling occurred on the Snake and Columbia rivers between August 19 and August 24, 1991. Collection was performed aboard a derrick barge supplied by Hickey Marine Enterprises. The barge was equipped with a spud anchoring system and positioned with a tugboat supplied by Tidewater Terminal Company. Sampling stations were determined by USACE personnel and MSL staff and were located through the use of compass headings and ranges provided in the River Cruising Atlas (Evergreen Pacific Publishing 1991) and from high altitude photographic information supplied by USACE. The stations were positioned at specific port areas where dredging may be required and at RM stations that would be subject to erosion during a drawdown operation. Topography, pre-determined distances from shore, and water depth were used to select sampling stations during a pre-planning meeting. MSL personnel then prepared station location maps for use in planning and implementation in the field program. During the planning process the deposition history of some of the sampling stations was unknown requiring decisions to be made in the field regarding the required sediment core length. The core lengths for all the stations are shown in Table 1.1.

A 19-ft Boston Whaler was used to locate sampling stations and record water depths using a calibrated fathometer. The whaler navigated the shoreline until the appropriate sampling station was reached. This location was confirmed by compass headings, ranges and comparison with sediment cross section drawings supplied by USACE. Once a sampling station was located, it was marked with weighted buoys.

After a sampling station was marked, the derrick barge was positioned near the buoy and maintained at this position by lowering the spud anchoring system. A 4-in.- diameter vibratory-hammer coring device with a steam-cleaned Lexan liner was lowered to the sediment surface and then vibrated to obtain a core between 3 and 7 ft in length. A cutterhead with a core catcher was used on the coring device. The thickness of the sediment substrate determined the core length at each site. Forty-four samples were collected for the Columbia and Snake rivers sampling project. For some stations, collection of sediment using a vibratory hammer was not possible and a Van Veen grab was used in its place. To obtain ample sediment for chemical analysis, two grab samples were required at each RM station. Sampling information such as date collected, number of cores or grabs, and equipment used to retrieve a sample, was recorded in data logs. The collected core samples were capped, labeled, cut into 18-in. sections, put in coolers, and placed

in a refrigerated storage container kept at 4°C onboard the barge. The Van Veen grab samples were placed in pre-cleaned core liners, capped, labelled, and stored in the refrigerated container at approximately 4°C.

Samples were collected at stations SRP 1 through SRP 34 with the 4-in. vibratory hammer. Samples were collected at stations SRP 50 through 56 with the Van Veen grab (Figures 1.1 through 1.11). No samples were obtained at stations SRP 5, SRP 6, SRP 8, SRP 10 and SRP 11, because only exposed bedrock was present. The collected sediment was shipped back to MSL for compositing and subsampling for chemistry. Shipments of coolers to MSL were made using overnight delivery.

2.2 COMPOSITING AND SUBSAMPLING FOR CHEMISTRY

Upon receipt of samples at MSL, cores were inventoried against chain-of-custody forms and stored at 4°C until composited for physical and chemical analysis. The compositing scheme was developed jointly by MSL representatives and the USACE point of contact. Criteria for compositing of sediment samples were as follows: location, function of port station, landmarks, and land topography. For example, SRP 14 through 22 were samples taken from the Port of Wilma. Based on materials that are shipped from and handled at various locations along the port berth, there was no reason to believe that samples taken from various locations within the Port of Wilma would be different; consequently, all of the sediment from SRP 14 through 22 was composited together and then subsampled for chemistry. Table 2.1 presents the scheme used for compositing the samples and the nomenclature used for the composites.

The following sequence of events occurred for compositing samples from each station and subsampling for chemistry: 1) each core was cut in half lengthwise, 2) the sediment was collected with a stainless steel spoon and mixed to a homogeneous consistency and color, 3) a 16-oz archive sample was then collected from each core, and kept at 4°C, should further analysis be required, 4) after each individual core was mixed, a subsample of each core comprising a composite was placed in a large, stainless steel bowl, and mixed to homogenous consistency and color. After thorough mixing, subsamples of this material were taken for grain size, TOC, TVS, ammonia, phosphorus, oil and grease, TPH, metals, PAHs, PCB/Pesticides, and PCDD/PCDFs.

Sulfides were sampled in a slightly different manner. To minimize sulfide loss through exposure to air, each core was opened and a syringe was inserted into the sediment to collect a sediment plug that was then used for sulfide analysis. This sample (4 mls of sediment) was then placed into a 4-oz, pre-cleaned I-Chem jar with 1 mL of zinc acetate to preserve the sample. At no time during this process was the sample mixed and the jar lid was immediately placed on the

TABLE 2.1. Compositing Scheme for the Columbia and Snake Rivers Sampling Stations

<u>Location</u>	<u>Sampling Station</u>	<u>Composite Name</u>	<u>Comments</u>
Walla Walla Grain Terminal	SRP 1 SRP 2	SRP 1,2 SRP 1,2	
Port of Kennewick	SRP 3 SRP 4	SRP 3,4 SRP 3,4	
Port of Burbank	SRP 5 SRP 6		Samples not obtained; bedrock Samples not obtained; bedrock
	SRP 7A	SRP 7A	
Sheffler Grain Terminal	SRP 8		Samples not obtained; bedrock
	SRP 9	SRP 9	Sampled for organics and metals only
Port of Almota	SRP 10 SRP 11		Samples not obtained; bedrock Samples not obtained; bedrock
RM 123.30 127.03 131.62	SRP 12 SRP 13 SRP 23	SRP 12 SRP 13 SRP 23	
Port of Wilma	SRP 14 SRP 15A SRP 16 SRP 17 SRP 18 SRP 19 SRP 20 SRP 21 SRP 22	SRP 14 - 22 SRP 14 - 22 SRP 14 - 22 SRP 14 - 22 SRP 14 - 22 SRP 14 - 22 SRP 14 - 22 SRP 14 - 22 SRP 14 - 22	
Port of Clarkston	SRP 24 SRP 25 SRP 26 SRP 27	SRP 24,25 SRP 24,25 SRP 26,27 SRP 26,27	

TABLE 2.1. (contd)

<u>Location</u>	<u>Sampling Station</u>	<u>Composite Name</u>	<u>Comments</u>
Port of Lewiston	SRP 28	SRP 28,29	
	SRP 29	SRP 28,29	
	SRP 30	SRP 30 - 32	
	SRP 31	SRP 30 - 32	
	SRP 32	SRP 30 - 32	
	SRP 33	SRP 33,34	
	SRP 34	SRP 33,34	
Boise Cascade	SRP 50	SRP 50	Samples obtained with a Van Veen grab
	SRP 51	SRP 51	Samples obtained with a Van Veen grab
RM 119.36 120.70 121.80	SRP 52	SRP 52	Samples obtained with a Van Veen grab
	SRP 53	SRP 53	Samples obtained with a Van Veen grab
	SRP 54	SRP 54	Samples obtained with a Van Veen grab
Port of Almota	SRP 55	SRP 55,56	Samples obtained with a Van Veen grab
	SRP 56	SRP 55,56	

jar to minimize the sample's exposure to air. This process continued until all of the cores comprising one sediment composite were opened and subsampled for sulfides. Zinc acetate was then added to the sample jar to equal a volume of 4 mL. At this time, the sediment in the 4-oz jar was thoroughly mixed with a stainless steel spatula. The lid was tightly secured and the sample was stored at 4°C until analyzed.

2.3 ANALYTICAL METHODS

This section discusses the analytical methods used for each of the parameters measured in the Snake and Columbia rivers sediment composites and the types of quality control samples that were analyzed to validate each measured parameter. Analytical methods that are commonly used, such as those for sediment conventional measurements or extraction procedures for pesticides and PCBs, are referenced and described briefly. More intricate methods, such as those for extraction and analysis of dioxins, are described in more detail.

2.3.1 Grain Size

Grain size of sediment composites was determined for four fractions: gravel, sand, silt, and clay, following the Puget Sound Estuary Program (PSEP) Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP 1986). These methods are consistent with

ASTM D421 (ASTM 1978) and D422 (ASTM 1972). Grain size analysis was performed by Soil Technologies, Inc., Bainbridge Island, Washington.

Approximately 25 g of sediment was removed for analysis of total solids while another 10- to 100-g aliquot was weighed for grain size analysis. To separate the coarser sand and gravel fraction from the silt/clay fraction, sediment was washed with distilled water through a 63.5- μ m (4.0 phi) sieve into a 1-L graduated cylinder. The coarse fraction was dried, weighed, and shaken through a nest of sieves to yield the required coarse subfractions. Any material still passing the final 63.5- μ m sieve was added to the previous fines to determine the silt and clay fraction.

Quality Control

One sample was analyzed for grain size in duplicate to assess precision of the method.

2.3.2 Total Organic Carbon

Total organic carbon analysis was performed at Analytical Resources Inc. (ARI), in Seattle, Washington. The TOC measurement included the amount of nonvolatile, partially volatile, volatile, and particulate organic compounds in a sample. The sediment sample was dried and ball-milled to a fine powder. Inorganic carbonate was then removed by acidification. The TOC in sediment was determined by measuring the carbon dioxide released during combustion of the sample (PSEP 1986; SW846 Method 9060, EPA 1986). Results of TOC analyses are reported as percent of dry weight.

Quality Control

One sample was analyzed in triplicate to assess precision of the method. A matrix spike and matrix spike duplicate were analyzed to determine accuracy.

2.3.3 Total Volatile Solids

Total volatile solids measures a fraction of total solids lost on ignition and is used as an estimate for the amount of organic matter in the total solids. Operationally, TVS is defined by the combustion temperature, and does not always represent the organic content of a sample. Some of the more volatile organic material may be lost during drying, and some inorganic material may be lost during combustion. Analysis of TVS was performed by ARI using the method defined in PSEP (1986). Following that method, the sample was freeze-dried to a constant weight and ball-milled to a fine powder. A portion was then removed, weighed, and combusted at 550°C. The sample was cooled in a desiccator and reweighed. The amount of sample lost during ignition was then defined as the volatile solids fraction. The TVS results are reported as a percent of dry weight.

Quality Control

One sample was analyzed in duplicate as a quality control check on precision.

2.3.4 Ammonia

Sediment composites were analyzed for ammonia using Methods 350.1 and 350.3 (EPA 1979) and were analyzed by ARI. The procedure involved extraction of the sediment using potassium chloride followed by measurement using an ion-specific electrode. Results of ammonia analyses are reported in mg N/kg.

Quality Control

Quality control of the ammonia determination consisted of analysis of one sample in duplicate to assess precision, and analysis of one spiked sample to assess accuracy. One method blank was also analyzed.

2.3.5 Phosphorus

Ortho-phosphate was determined in sediments using a modification of EPA Method 365.2, which applies to aqueous matrices (EPA 1979). Samples were analyzed by ARI. The procedure involved mixing the sediment sample with an equal amount of water to make a 1:1 aqueous extract. The aqueous portion of the sample was reacted with a series of reagents to form a blue colored complex. The intensity of the blue color, which is proportional to the concentration of phosphorus, is measured spectrophotometrically. Results of phosphorus analyses are reported in mg P/kg.

Quality Control

Quality control of the phosphorus determination consisted of analysis of one sample in duplicate to assess precision. One method blank was also analyzed.

2.3.6 Sulfide

Sediment composites were analyzed for sulfide according to the PSEP (1986) method and were analyzed by ARI. The procedure involved a distillation followed by spectrophotometric analysis. Results of sulfide analyses are reported in mg S/kg.

Quality Control

Quality control of the sulfide determination consisted of analysis of one sample in duplicate to assess precision. One method blank was also analyzed.

2.3.7 Oil and Grease/Total Petroleum Hydrocarbons

Total oil and grease includes vegetable oils, animal fats, soaps, waxes, and any other carbon-hydrogen material extractable by the solvent trichlorotrifluoroethane (Freon). Total petroleum hydrocarbons comprise the nonpolar mineral fraction of total oil and grease that is not removed by silica gel absorption. Oil and grease and TPH analyses were performed by ARI. Sediment composites were first dried with sodium sulfate. Oil and grease were removed from the dried samples by Soxhlet extraction with Freon according to Method SW-846 9071 (EPA 1986). Infrared spectrophotometry (IR) was used to determine concentrations of oil and grease following Method 413.2 (EPA 1979). For total oil and grease, sample extracts were scanned from 4000 to 600 cm^{-1} on an infrared spectrophotometer and the peak height was measured at 2930 cm^{-1} . This wavelength represents the $-\text{CH}_2$ configurations of hydrocarbons and was the standard used to determine oil and grease concentrations. Concentrations of petroleum hydrocarbons were determined by IR using Method 418.1 (EPA 1979). For TPHs, silica gel was added to the extract removing the more polar animal and vegetable based oils. The extract was then shaken and allowed to settle. An aliquot was removed and scanned the same way as the oil and grease sample. The relationship of peak height to oil concentration was determined by the regression of the peak height versus a known concentration of fuel oil. Results of oil and grease analyses and TPH are reported in mg/kg dry weight.

Quality Control

Precision of the oil and grease and TPH methods was assessed by the analysis of one sample in duplicate. Accuracy was assessed by the analysis of a matrix spike and matrix spike duplicate. Two method blanks were also analyzed.

2.3.8 Metals

Seven metals were measured in the Snake and Columbia rivers sediment composites: arsenic (As), cadmium (Cd), chromium (Cr), mercury (Hg), lead (Pb), copper (Cu), and zinc (Zn). All metals analyses were performed by ARI using a combination of three different methods, all of which involved a sample digestion followed by instrumental analysis. For analysis of Cd, Cr, Cu, and Zn, samples were first acid digested using nitric acid according to EPA SW-846 Method 3005 (EPA 1986). Concentrations of these four metals were then determined by inductively coupled plasma emission spectrometry (ICP) according to EPA SW-846 Method 6010 (EPA 1986). For analysis of As and Pb, samples were acid digested using hydrochloric acid according to EPA SW-846 Method 3050 (EPA 1986). Concentrations of As and Pb in samples were then determined by graphite-furnace atomic absorption spectroscopy (GFAA) following EPA SW-846 Method 7000 (EPA 1986). For Hg analysis, samples were prepared according to the EPA CLP procedure for Hg in soil. Concentrations of Hg in samples were determined using cold-vapor

atomic absorption spectroscopy (CVAA) according to EPA SW-846 Method 7471 (EPA 1986). Results of metals analyses are reported in mg/kg dry weight.

Quality Control

To assess the precision of the analytical methods for metals determination, two samples were analyzed in duplicate. Two matrix spike samples were analyzed to assess accuracy. Four standard reference material (SRM) samples were also analyzed to determine accuracy. Four method blanks were analyzed with the samples.

2.3.9 Polynuclear Aromatic Hydrocarbons

Sediment composites were analyzed by ARI for the following 18 PAH compounds:

naphthalene	2-methylnaphthalene
acenaphthylene	acenaphthene
dibenzofuran	fluorene
phenanthrene	anthracene
fluorene	pyrene
benzo(a)anthracene	chrysene
benzo(b)fluoranthene	benzo(k)fluoranthene
benzo(a)pyrene	indeno(1,2,3-cd)pyrene
dibenzo(a,h)anthracene	dibenzo(g,h,i)perylene

Samples for PAH analysis were prepared using a methylene chloride/acetone extraction according to EPA SW-846 Method 8080 (EPA 1986). Polynuclear aromatic hydrocarbons were quantified using gas chromatography/mass spectroscopy (GC/MS) in the Selective Ion Mode (SIM) following EPA SW-846 Method 8270 (1986). Results of PAH analyses are reported in µg/kg dry weight.

Quality Control

To assess precision of the method, one sample was analyzed in duplicate. Two aliquots were taken from one sample and spiked with acenaphthene, fluorene, and fluoranthene to create a matrix spike and a matrix spike duplicate that were analyzed to assess accuracy. One method blank was also analyzed.

2.3.10 Chlorinated Pesticides And Polychlorinated Biphenyls

Analysis of sediment composites for chlorinated pesticides and PCBs was conducted by ARI. Chlorinated pesticides and PCBs were extracted simultaneously with the PAH compounds using EPA SW-846 Method 3550 (1986). Following the methylene chloride/acetone extraction, interferences were removed by passing the extract through a column packed with 10 g of 7% deactivated alumina. Most samples required an additional cleanup treatment using gel permeation chromatography (GPC) to remove other interferences. Concentrations of chlorinated pesticides

and PCBs in samples were determined using gas chromatography with electron capture detection (GC/ECD) following EPA SW-846 Method 8080 (EPA 1986). Results of pesticide and PCB analyses are reported in µg/kg dry weight.

Quality Control

To monitor extraction efficiency the surrogates, dibutylchlorodendate and tetrachloromethane were added to each sample prior to extraction. For chlorinated pesticides, one sample was analyzed in duplicate to assess precision. One sample was also analyzed in duplicate for PCBs. To assess accuracy, two aliquots were taken from one sample and spiked with dieldrin, endrin, and heptachlor to create a matrix spike and a matrix spike duplicate. Standard reference material SQ-1 was analyzed for both pesticides and PCBs; five method blanks were included with the analyses.

2.3.11 Polychlorinated Dibenzodioxins and Dibenzofurans

Sediment composites were analyzed by Keystone NEA (Tigard, Oregon) for the following 17, 2,3,7,8-substituted isomers of PCDD and PCDFS:

<u>Compound</u>	<u>Abbreviation</u>
2,3,7,8-tetrachlorodibenzodioxin	(2378-TCDD)
1,2,3,7,8-pentachlorodibenzodioxin	(12378-PeCDD)
1,2,3,4,7,8-hexachlorodibenzodioxin	(123478-HxCDD)
1,2,3,6,7,8-hexachlorodibenzodioxin	(123678-HxCDD)
1,2,3,7,8,9-hexachlorodibenzodioxin	(123789-HxCDD)
1,2,3,4,6,7,8-heptachlorodibenzodioxin	(1234678-HpCDD)
octachlorodibenzodioxin	(OCDD)
2,3,7,8-tetrachlorodibenzofuran	(2378-TCDF)
1,2,3,7,8-pentachlorodibenzofuran	(12378-PeCDF)
2,3,4,7,8-pentachlorodibenzofuran	(23478-PeCDF)
1,2,3,4,7,8-hexachlorodibenzofuran	(123478-HxCDF)
1,2,3,6,7,8-hexachlorodibenzofuran	(123678-HxCDF)
2,3,4,6,7,8-hexachlorodibenzofuran	(234678-HxCDF)
1,2,3,7,8,9-hexachlorodibenzofuran	(123789-HxCDF)
2,3,7,8-tetrachlorodibenzodioxin	(2378-TCDD)
1,2,3,4,6,7,8-heptachlorodibenzofuran	(1234678-HpCDF)
1,2,3,4,7,8,9-heptachlorodibenzofuran	(1234678-HpCDF)
octachlorodibenzofuran	(OCDF)

Sediment composites were analyzed for congeners of PCDDs and PCDFs using a modified EPA Draft Method 8290 (EPA 1987). This method is referred to as an isotope dilution method, because isotopes of each compound of interest are added to the samples as internal standards prior to extraction for final quantitation.

Several modifications were made to EPA Method 8290 for these dioxin analyses to improve quantitation. The EPA Method 8290 requires a five-point calibration curve that is analyzed once. The calibration curve used for the Snake and Columbia rivers sample analyses

was created by analyzing each calibration solution three times over a period of approximately one week. The calibration standards for this study were independently prepared and certified at concentrations specified in EPA Method 1613. The EPA method also requires the use of the tetra- and penta- labeled, internal standard at a level of 50 pg/ μ L (pg = picograms). The calibration curve for these analyses used labeled, internal standards at concentrations of 100 pg/ μ L for all of the isomers except OCDD, which was at 200 pg/ μ L. Instead of using the internal standard solution containing 9 of the 17 quantitation standards as specified in Method 8290, the internal standards used for the Snake and Columbia rivers sediment analyses contained 16 of the labeled analogues 2,3,7,8-substituted isomers. To prevent changes in concentration as a result of solvent losses, the standards for these analyses were prepared in tetradecane; the EPA method specifies tridecane.

Sediment composites were homogenized with precleaned sand, spiked with isotopically labeled internal standards, and extracted for 24 h with benzene in a soxhlet extraction apparatus. Extracts were then reduced and exchanged into hexane using a Kuderna-Danish (KD) concentrator and spiked with a cleanup recovery standard to measure laboratory performance in the subsequent cleanup steps of the procedure. The hexane extracts were run through a series of base and acid washing treatments to remove matrix interferences. The recovery internal standards were added followed by fractionation through three chromatography cleanup columns.

The sample extracts were analyzed for the presence of PCDDs and PCDFs using high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). The PCDD/PCDFS isomers were quantified by comparison of their responses to the responses of the labeled internal standards. Results for all of the PCDD and PCDFS isomers except 2378-TCDF were obtained using a DB-5 capillary column. The reported concentrations measured for 2378-TCDF were obtained using a DB-225 column. Results of PCDD and PCDFS analyses are reported in pg/g or parts per trillion (pptr) dry weight.

Quality Control

To assess extraction efficiency and accuracy, each sample was spiked with 16 labeled analogues 2,3,7,8-substituted isomers. One compound, $^{13}\text{C}_{12}$ -123789-HxCDD, was used as a recovery standard; its native analyte was quantified against 1,2,3,6,7,8-HxCDD. As noted above, a cleanup recovery standard $^{137}\text{C}_{14}$ -2378-TCDD, was added to each sample after extraction, but before extract cleanup, to assess any loss of analytes during the sample preparation procedure.

3.0 RESULTS

This section contains the sediment chemistry results and associated quality control. All results are reported on a percent dry weight basis. Eighteen sediment composites were analyzed for conventional parameters, and 19 sediment composites were analyzed for metals and organics. At the request of USACE sediment composite SRP 9 was excluded from conventional analysis. Quality control methods for each analysis may contain method blanks, analytical duplicates or triplicates, matrix spikes and matrix spike duplicates, internal standards, and standard reference materials. Method blank samples were used primarily to assess possible sample contamination. Analytical duplicates and triplicates were used to assess precision or repeatability of a given result. Calculations used to measure precision were relative percent differences (RPD) and relative standard deviations (RSD). Matrix spikes, internal standards, and SRMs were used to assess the accuracy of an analytical method. Quality control sample summaries and the results for each chemical or physical parameter are described in the following sections.

3.1 GRAIN SIZE

The results for grain size analysis are presented in Table 3.1. Four sediment composites, SRP 14 through 22 (Port of Wilma), SRP 28,29, 30 through 32 (Port of Lewiston), and SRP 51(Boise Cascade Mill) had sediment which was predominantly gravel-sized or larger. Eight composites SRP 1,2 (Walla Walla Grain Terminal), SRP 3,4 (Port of Kennewick), SRP 7A (Port of Burbank), SRP 24-27 (Port of Clarkston), SRP 50 (Boise Cascade Mill), and SRP 55, 56 (Port of Almota) were sandy coarse-grained sediment. The remaining seven composites consisted mostly of silty sands, ranging from 3.9 to 67.5 μm ; of these, six are RM composites (SRP 12, 13, 23, 52, 53, and 54).

The RPD between the duplicate samples was 0%, an indication of excellent method precision. Matrix spikes and standard reference materials do not apply to grain size analyses.

3.2 SEDIMENT CONVENTIONALS

3.2.1 Percent Total Volatile Solids

Results of TVS analyses and other sediment conventional measurements are shown in Table 3.2; results of quality control samples associated with those measurements are shown in Table 3.3.

Concentrations of TVS ranged from 0.91% to 7.18%. Sediments that were predominantly silty (SRP 12,13,23,52,53,54) had the highest concentrations of TVS. The exception to this

TABLE 3.1. Sediment Grain Size Results for the Columbia and Snake Rivers Sampling Project

<u>Sediment Composite</u>	<u>%Gravel ≥2,000 μm</u>	<u>%Sand 2,000-62.5 μm</u>	<u>%Silt 62.5-3.9 μm</u>	<u>%Clay <3.9 μm</u>
SRP 1,2	0	59	33	8
SRP 1,2 (Rep)	0	59	33	8
SRP 3,4	4	82	9	5
SRP 7A	0	63	29	8
SRP 12	0	9	71	20
SRP 13	0	29	59	12
SRP 14-22	24	58	10	8
SRP 23	0	40	49	11
SRP 24,25	4	77	13	6
SRP 26,27	0	59	33	8
SRP 28,29	18	64	13	5
SRP 30-32	20	72	6	2
SRP 33,34	1	96	1	2
SRP 50	1	61	33	5
SRP 51	20	23	53	4
SRP 52	0	30	62	8
SRP 53	0	26	63	11
SRP 54	0	19	67	14
SRP 55,56	0	96	3	1

TABLE 3.2. Sediment Conventional Results for the Columbia and Snake Rivers Sampling Project

<u>Sediment Composite</u>	<u>% TVS</u>	<u>% TOC</u>	<u>NH3-N (mg N/kg)</u>	<u>PO4-P (mg P/kg)</u>	<u>Sulfide (mg S/kg)</u>
SRP 1,2	1.89	0.55	12.6	0.07	1.9
SRP 3,4	1.51	0.56	15.1	0.06	2.4
SRP 7A	2.23	0.63	35.1	0.23	3.6
SRP 12	3.15	5.33	18.8	0.12	75.1
SRP 13	5.34	2.70	20.1	0.22	131.0
SRP 14-22	2.11	1.47	14.1	0.10	3.5
SRP 23	5.95	4.30	20.1	0.04	66.2
SRP 24,25	2.36	1.06	21.7	0.15	22.1
SRP 26,27	5.26	2.61	34.1	0.03	41.8
SRP 28,29	1.45	0.44	1.6	< 0.01	< 1.7
SRP 30-32	1.10	0.34	7.2	0.04	0.3
SRP 33,34	1.69	0.59	6.4	0.04	0.3
SRP 50	1.70	0.28	6.0	0.08	< 1.2
SRP 51	2.18	0.62	13.1	0.04	< 1.2
SRP 52	4.46	2.78	4.3	0.03	57.1
SRP 53	6.12	2.86	4.8	0.06	61.9
SRP 54	7.18	3.90	4.0	0.17	122.2
SRP 55,56	0.91	0.16	0.1	0.16	< 0.5

TABLE 3.3. Quality Control Data for the Sediment Conventional Results

Quality Control Methods	% TVS	% TOC	NH3-N (mg N/kg)	PO4-P (mg P/kg)	Sulfide(a) (mg S/kg)
<u>Analytical Duplicates</u>					
SRP 7A	2.23	ND(b)	ND	ND	ND
SRP 7A	2.11	ND	ND	ND	ND
RPD	5.53	ND	ND	ND	ND
I-STAT	0.03	ND	ND	ND	ND
SRP 12	ND	ND	ND	0.12	ND
SRP 12	ND	ND	ND	0.05	ND
RPD	ND	ND	ND	82.35	ND
I-STAT	ND	ND	ND	0.41	ND
SRP 26,27	ND	ND	34.1	ND	ND
SRP 26,27	ND	ND	37.5	ND	ND
RPD	ND	ND	9.50	ND	ND
I-STAT	ND	ND	0.05	ND	ND
<u>Analytical Triplicates</u>					
SRP 14-22	ND	1.47	ND	ND	ND
SRP 14-22	ND	1.44	ND	ND	ND
SRP 14-22	ND	1.30	ND	ND	ND
RSD	ND	6.59%	ND	ND	ND
SRP 12	ND	ND	ND	ND	75.1
SRP 12	ND	ND	ND	ND	45.4
SRP 12	ND	ND	ND	ND	63.7
RSD	ND	ND	ND	ND	24.39
<u>Method Blank</u>					
Blank I	ND	0.022	0.002	<0.0005	<0.002
Blank II	ND	0.027	ND	ND	<0.002
MDL(c)	ND	0.053	0.0005	0.0005	0.002
<u>Matrix Spike</u>					
SRP 14-22	1.47	4.78	ND	ND	ND
Amount Spiked	1.12	3.66	ND	ND	ND
Concentration Recovered	2.66	8.67	ND	ND	ND
Percent Recovery	ND	106.21	ND	ND	ND

TABLE 3.3. (contd)

Quality Control Methods	% TVS	% TOC	NH3-N (mg N/kg)	PO4-P (mg P/kg)	Sulfide (mg S/kg)
SRP 26,27	ND	ND	34.1	ND	ND
Amount Spiked	ND	ND	0.5	ND	ND
Concentration					
Recovered	ND	ND	46.3	ND	ND
Percent Recovery	ND	ND	---(d)	ND	ND
SRP 12	ND	ND	ND	0.12	75.1
Amount Spiked	ND	ND	ND	0.92	390.3
Concentration					
Recovered	ND	ND	ND	0.08	292.8
Percent Recovery	ND	ND	ND	*(e)	55.78
<u>Matrix Spike Duplicate</u>					
SRP 14-22	ND	1.47	ND	ND	ND
Amount Spiked	ND	1.08	ND	ND	ND
Concentration					
Recovered	ND	2.53	ND	ND	ND
Percent Recovery	ND	98.37	ND	ND	ND
SRP 26,27	ND	ND	34.1	ND	ND
Amount Spiked	ND	ND	0.5	ND	ND
Concentration					
Recovered	ND	ND	44.9	ND	ND
Percent Recovery	ND	ND	-	ND	ND
SRP 12	ND	ND	ND	0.12	75.1
Amount Spiked	ND	ND	ND	0.91	476.7
Concentration					
Recovered	ND	ND	ND	0.09	410.5
Percent Recovery	ND	ND	ND	*	70.36

(a) Sulfides were run according to PSEP (1986) protocol with methylene blue colorimetric finish.

(b) ND No data.

(c) MDL Method detection limit.

(d) --- Ammonia determined on 1:1 2M KCL extracts with ion specific electrode finish. Samples were spiked at a level too low to adequately detect; hence no recoveries are reported.

(e) * Ortho-Phosphate determined on 1:1 aqueous extracts with acid molybdate/ascorbic finish. Note there was no recovery of added spike.

trend was SRP 26,27 (Port of Clarkston), which had relatively high TVS levels of 5.26% but consisted mainly of coarse grained sand.

Sediment composite SRP 7A (Port of Burbank) was analyzed in duplicate and had a RPD of 5.53%, which was within the QA/QC goals of $\pm 10\%$ established for relative precision. Matrix spikes and SRMs do not apply to TVS analysis.

3.2.2 Percent Total Organic Carbon

The results of TOC are presented in Tables 3.2 and 3.3. Concentrations of TOC ranged from 0.16% to 5.33%. Sediment with the highest percentages of TOC were SRP 12, 13, 23, 52, 53, and 54 (RM composites), which came from locations of predominantly silt or finer sediment. SRP 26,27 (Port of Clarkston) was the exception to this pattern with a high TOC content of 2.61% and a grain size of predominantly sand (59%).

Sediment composite SRP 14 through 22 was analyzed in triplicate and had a RSD of 6.59%, which was within the QA/QC goal of $\pm 10\%$. The results for the two method blanks were 0.022% and 0.027%; both samples were below the method detection limit (MDL) of 0.053%. The matrix spike and matrix spike duplicates for sediment composite SRP 14 through 22 (Port of Wilma) showed recoveries of 106% and 98%, respectively. No QA/QC requirements for percent recoveries of TOC were established.

3.2.3 Ammonia as Nitrogen ($\text{NH}_3\text{-N}$)

The results of ammonia analysis are presented in Tables 3.2 and 3.3. Ammonia concentrations varied by a factor of 350 with levels ranging from 0.1 mg N/kg at SRP 55,56 (Port of Almoda) to 35.1 mg N/kg at SRP 7A (Port of Burbank). Concentrations in the majority of sediment composites ranged from 12.6 mg N/kg to 35.1 mg N/kg. Sediment grain size appeared to be unrelated to ammonia levels because those stations with elevated ammonia concentrations, varied in grain size between sand and silt.

Sediment composite SRP 26,27 (Port of Clarkston) was analyzed in duplicate and had a RPD of 9.50% and an I-STAT of 0.05. No QA/QC precision requirements were not established for ammonia. One blank was analyzed with the sediment samples and had 0.002 mg N/kg, which was slightly higher than the achieved MDL of 0.0005 mg N/kg. The matrix spike and matrix spike duplicate of this composite were spiked at a level too low to be adequately detected; therefore, percent recoveries could not be reported.

3.2.4 Total Phosphorus

The results for total phosphorus are presented in Tables 3.2 and 3.3. Total phosphorus concentrations ranged from <0.01 to 0.23 mg P/kg. Sediment composite SRP 7A (Port of Burbank) exhibited the highest levels of ammonia and total phosphorus (see Figure 1.5 for SRP

7A location). However, other stations with elevated ammonia did not have elevated phosphorus levels (i.e., SRP 54 and SRP 55,56).

Sediment composite SRP 12 (RM 123.3) was analyzed in duplicate to assess precision, and produced results of 0.12 mg P/kg and 0.05 mg P/kg, with a calculated RPD of 82.4% and an I-STAT of 0.41. There are no criteria for precision stated for this method; therefore, no corrective action was taken. One blank sample was analyzed with the sediment samples and was found to be less than the achieved MDL of 0.0005 mg P/kg. Matrix spike and the matrix spike duplicate recoveries of sediment composite SRP 12 was 0%. The reason for this low recovery is unknown, it is possible that when the method was adapted to sediment samples, matrix interferences developed. Because of inadequate quality control results, the actual phosphorus concentrations for the Snake and Columbia rivers samples may be different than those reported.

3.2.5 Total Sulfides

The results for total sulfides are presented in Tables 3.2 and 3.3. Concentrations of total sulfides varied by a factor of 437 with a range of 0.3 mg S/kg to 131.0 mg S/kg. Ten sediment composites had concentrations of 3.6 mg S/kg or lower. The remaining eight composites (six from RM composites) had concentrations of 22.1 mg S/kg or higher and were from areas of fine-grained sediment with higher levels of TOC and TVS.

Sediment composite SRP 12 (RM 123.30) was analyzed in triplicate to assess precision, and produced a calculated RSD of 24.4%. There are no criteria for precision stated for this method. Two blank samples were analyzed and found to be less than the achieved method detection limit of 0.002 mg S/kg. Matrix spike and matrix spike duplicate recoveries of sediment composite SRP 12 were 56% and 70%. Criteria for percent recoveries were not established for total sulfides.

3.3 OIL AND GREASE AND TOTAL PETROLEUM HYDROCARBONS

Results of oil and grease and TPH are shown in Table 3.4; results of quality control samples associated with those samples are shown in Table 3.5. Sediment composite SRP 3,4 (Port of Kennewick) had the lowest detectable concentrations of oil and grease at 13.98 mg/kg. Sediment composite SRP 55,56 (Port of Almot) had the lowest detectable concentration of TPH (13.50 mg/kg).

Four composites from RM stations (SRP 12, SRP 23, SRP 53, and SRP 54) had the highest concentrations of oil and grease and TPH, ranging from 174.85 to 208.70 mg/kg and 84.34 to 96.27 mg/kg, respectively (Table 3.4).

TABLE 3.4. Sediment Oil and Grease and Total Petroleum Hydrocarbon Results for the Columbia and Snake Rivers Sampling Project

<u>Sediment Composite</u>	<u>Oil and Grease (mg/kg dry wt)</u>	<u>TPH (mg/kg dry wt)</u>
SRP 1,2	28.46	27.10
SRP 3,4	13.98	15.25
SRP 3,4 Dup	16.52	15.25
SRP 7A	26.82	20.12
SRP 9	12.62 U(a)	12.62 U
SRP 12	208.70	95.65
SRP 13	100.48	61.31
SRP 14-22	62.75	37.14
SRP 23	195.43	87.94
SRP 24,25	84.83	49.73
SRP 26,27	105.82	57.72
SRP 28,29	14.63	12.20 U
SRP 30-32	34.84	28.62
SRP 33,34	15.97	17.30
SRP 50	32.08	19.25
SRP 51	43.19	32.72
SRP 52	117.85	70.03
SRP 53	174.85	96.27
SRP 54	178.98	84.34
SRP 55,56	13.50 U	13.50

(a) U The analyte was not present above the level of the associated value.

Sediment composite SRP 3,4 (Port of Kennewick) was analyzed in duplicate and had a RPD of 16.7% and an I-STAT of 0.08, which was within the QA/QC goal of $\pm 20\%$ established for relative precision. Two method blanks were analyzed for oil and grease, which were found to be undetectable at the achieved detection limit of 10 mg/kg. Matrix spike and the matrix spike duplicate recoveries of SRP 50 (Boise Cascade) were 116.2% and 108.6%, respectively, falling within the QA/QC goal of 50% to 150% for oil and grease. For TPH analyses, the RPD for SRP 3,4 (Port of Kennewick) was 0%, an indication of excellent method precision. Two method blanks analyzed for TPH produced undetectable concentrations at the achieved detection limit of 10 mg/kg. Matrix spike and the matrix spike duplicate recoveries for TPH of SRP 50 (Boise Cascade) were 142.8% and 135.2%, respectively, and fell within the QA/QC goal of 50% to 150% recovery.

TABLE 3.5. Quality Control Data for Oil and Grease and TPH Results

<u>Quality Control Methods</u>	<u>Oil and Grease (mg/kg dry wt)</u>	<u>TPH (mg/kg dry wt)</u>
<u>Analytical Duplicates</u>		
SRP 3,4	13.98	15.25
SRP 3,4 Dup	16.52	15.25
RPD	16.66	0.00
I-STAT	0.08	0.00
<u>Method Blanks</u>		
Blank 1	10 U(a)	10 U
Blank 2	10 U	10 U
<u>Matrix Spike</u>		
SRP 50	32.1	19.3
Amount Spiked	50	50
Concentration		
Recovered	90.2	90.7
Percent Recovery	116.2	142.8
<u>Matrix Spike Duplicate</u>		
SRP 50	32.1	19.3
Amount Spiked	50	50
Concentration		
Recovered	86.4	86.9
Percent Recovery	108.6	135.2
RPD	6.76	5.47
I-STAT	0.03	0.03

(a) U Analyte was not present above the level of associated value.

3.4 METALS

Nineteen sediment composites were analyzed for seven metals. Results of these analyses are provided in Table 3.6 and results of quality control samples associated with those analyses are shown in Table 3.7. In general, elevated levels of Ar, Cr, Cu, and Hg in the sediment composites were related to grain size and TOC and TVS. Composites with the highest levels of Ar, Cr, Cu, and Hg were RM composites that were predominantly fine-grained with had levels of TOC ranging from 2.70% to 5.33% and TVS levels ranging from 3.15% to 7.18%. Cadmium Pb, and Zn were not related to grain size, TOC, or TVS. SRP 3,4 had the highest levels of Cd, Pb, and Zn and was predominantly sand (82%) with lower concentrations of TOC (0.56%) and TVS (1.51%) than most of the other sediment composites.

3.4.1 Arsenic

Concentrations of arsenic ranged from 1.1 mg/kg to 9.46 mg/kg. Sediment composites SRP 23 (RM 131.62), SRP 12 (RM 123.3), and SRP 54 (RM 121.8) had the three highest concentrations of As at 9.6 mg/kg, 9.5 mg/kg, and 7.5 mg/kg, respectively.

3.4.2 Cadmium

Four sediment composites SRP 1,2 (Walla Walla Grain Terminal), SRP 3,4 (Port of Kennewick), SRP 24,25 (Port of Clarkston), and SRP 50 (Boise Cascade) had Cd concentrations above the detection limit, ranging from 0.2 mg/kg to 1.6 mg/kg. The Port of Kennewick composite had the highest concentrations of Cd with levels eight times higher than any other composite.

3.4.3 Chromium

Chromium concentrations varied over a smaller range than the other metals from 6.6 mg/kg to 23.4 mg/kg. The three composites with the highest Cr concentrations were SRP 13 (RM 127.03), SRP 23 (RM 131.62), SRP 53 (RM 120.7), and SRP 54 (RM 121.8).

3.4.4 Copper

Copper concentrations ranged from 6.9 mg/kg to 38.8 mg/kg. Sediment composites SRP 30-32 and SRP 33,34 (Port of Lewiston) had the lowest Cu concentrations of 8.4 mg/kg and 6.9 mg/kg, respectively. Sediment composites from SRP 23 (RM 131.62), SRP 54 (RM 121.8), and SRP 12 (RM 123.3), had the highest concentrations of 38.8 mg/kg, 36.3 mg/kg, and 35.2 mg/kg, respectively.

3.4.5 Lead

Concentrations of Pb ranged from 2.5 mg/kg to 20.8 mg/kg. The highest Pb concentration was found in sediment composite SRP 3,4 (Port of Kennewick).

TABLE 3.6. Sediment Metal Results for the Columbia and Snake Rivers Project

Sediment Composite	Metal (mg/kg dry weight)						
	As	Cd	Cr	Cu	Pb	Hg	Zn
SRP 1,2	3.1	0.2	14.3	15.5	7.7	0.06 U	62.6
SRP 3,4	4.0	1.6	20.1	20.2	20.8	0.06 U	277
SRP 7A	5.7	0.2 U ^(a)	16.3	17.2	7.1	0.06 U	51.5
SRP 9	4.5	0.2 U	11.8	18.4	7.8	0.04 U	51.0
SRP 12	9.5	0.4 U	19.3	35.2	18.4	0.20	67.8
SRP 13	5.2	0.4	20.8	33.3	10.6	0.10	68.5
SRP 13 dup	4.7	0.3 U	22.5	33.9	10.4	0.14	70.9
SRP 14-22	4.4	0.2 U	18.2	23.8	7.6	0.06	55.8
SRP 23	9.6	0.4 U	23.4	38.8	16.3	0.16	78.7
SRP 24,25	3.3	0.2	13.3	24.0	6.7	0.06 U	49.3
SRP 26,27	4.5	0.2 U	15.2	27.0	9.5	0.07 U	58.2
SRP 28,29	1.4	0.2 U	11.6	13.1	3.8	0.05 U	30.5
SRP 30-32	1.1	0.2 U	6.6	8.4	2.5	0.03 U	29.1
SRP 33,34	1.3	0.2 U	7.2	6.9	3.0	0.06 U	26.0
SRP 50	3.6	0.2	15.2	15.2	6.45	0.05 U	52.2
SRP 50 dup	3.5	0.2	16.0	15.2	6.22	0.05 U	54.1
SRP 51	2.8	0.2 U	11.3	18.1	6.0	0.05 U	57.5
SRP 52	5.4	0.3 U	16.2	22.2	9.5	0.07	56.8
SRP 53	7.3	0.4 U	21.6	34.7	14.2	0.14	78.4
SRP 54	7.5	0.3 U	21.4	36.3	15.6	0.16	76.9
SRP 55,56	3.3	0.2 U	13.1	9.6	4.1	0.06	37.4

(a) U Analyte was not present above the level of the associated value

TABLE 3.7. Quality Control Data for the Metal Results

Quality Control Methods	Metal (mg/kg dry weight)						
	As	Cd	Cr	Cu	Pb	Hg	Zn
<u>Analytical Duplicates</u>							
SRP 50	3.63	0.2	15.2	15.2	6.45	0.05 U ^(a)	52.2
SRP 50 dup	3.47	0.2	15.2	15.2	6.22	0.05 U	54.1
RPD %	4.51	0	5.13	0	3.63	0.00	3.58
I-STAT	0.23	0	0.026	0	0.18	0.00	0.02
SRP 13	5.21	0.4	20.8	33.3	10.6	0.10	68.5
SRP 13 dup	4.71	0.3 U	22.5	33.9	10.4	0.14	70.9
RPD %	10.08	NA ^(b)	7.85	1.79	1.91	33.33	3.44
I-STAT	0.05	NA	0.04	0.01	0.01	0.17	0.02
<u>Method Blank</u>							
Blank I	0.1 U	0.2 U	0.5 U	0.3	0.1 U	0.1 U	0.70
Blank II	0.1 U	0.2 U	0.5 U	0.2 U	0.1 U	0.1 U	0.50
Blank III	0.1 U	0.2 U	0.5 U	0.4	0.1 U	0.1 U	0.70
Blank IV	0.1 U	0.2 U	0.5 U	0.4	0.1 U	0.1 U	2.40
<u>Matrix Spike^(c)</u>							
SRP 50	3.6	0.2	15.2	15.2	6.45	0	52.2
Amount Spiked	9.9	8.7	21.6	8.7	9.94	0.51	43.3
Concentration Recovered	13.9	8.3	37.9	24.0	15.5	0.51	92.7
Percent Recovery	103.3	93.5	105.1	101.6	91.1	100.00	93.5

3.11

TABLE 3.7. (contd)

Quality Control Methods	Metal (mg/kg dry weight)						
	As	Cd	Cr	Cu	Pb	Hg	Zn
<u>Matrix Spike</u>							
SRP 14-22	4.4	0.2 U	18.2	23.8	7.6	0.06	55.8
Amount Spiked	11.5	11.7	29.3	11.7	11.5	0.56	58.69
Concentration							
Recovered	17.2	10.6	48.5	36.0	19.9	0.55	119.0
Percent Recovery	111.3	90.6	103.4	104.3	107.0	87.5	107.7
<u>Standard Reference Material</u>							
SRM-1	9.8	0.3	37.7	15.7	23.4	0.06	106
Certified Value	11.6	0.4	76.0	18.0	28.20	0.063	138
Range	10.3-12.9	0.29-0.43	73-79	15-21	26.4-30	0.051-0.075	132-144
SRM-2	20.4	3.1	78	97.7	167	1.24	390
Certified Value	23.4	3.5	135	98.6	161	1.44	438
Range	22.6-24.2	3.23-3.67	130-140	93.6-103.6	144-178	1.37-1.51	426-450
SRM-3	64	54	61	221	24	1.33	342
Certified Value	40	52	58	201	38	1.40	325
Range	15-65	33-64	44-70	158-245	19-46	0.7-2.1	276-421
SRM-4	65	54	62	228	23	1.4	349
Certified Value	40	52	58	201	38	1.4	325
Range	15-65	33-64	44-70	158-245	19-46	0.7-2.1	276-421

(a) U Analyte was not present above the level of the associated value.

(b) NA Not applicable.

(c) Control Limit of 75% to 125%.

3.4.6 Mercury

Eight sediment composites had detectable Hg concentrations ranging from 0.06 mg/kg to 0.2 mg/kg. The highest concentration of Hg was found in sediment composite SRP 12 (RM 123.30). The lowest detectable concentrations of Hg were found in sediment composites SRP 14-22 (Port of Lewiston) and SRP 55,56 (Port of Almota).

3.4.7 Zinc

Concentrations of Zn ranged from 26 mg/kg to 277 mg/kg. Sediment composite SRP 3,4 (Port of Kennewick) had the highest concentration of Zn at 277 mg/kg.

Two sediment composites, SRP 13 (RM 127.03) and SRP 50 (Boise Cascade), were analyzed in duplicate for each metal to assess precision. The RPDs between the duplicate analyses were within the QA/QC goal of $\pm 20\%$ set for relative precision for all metals except Hg. Analysis of Hg for SRP 13 (RM 127.03) exceeded the QA/QC goal of $\pm 20\%$ with a RPD of 33.33%. The elevated RPD is probably attributable to the variability in the low concentrations detected in these composites; therefore, no corrective action was taken.

All method blank results for As, Cd, Cr, Cu, and Pb were at or below the method detection limit. Results for Hg in all four blanks were 0.1 mg/kg, which is slightly above the detection limit of 0.05 mg/kg. Three of the four blanks had Zn levels lower than the detection limit of 1.0 mg/kg. The fourth blank had a Zn concentration of 2.4 mg/kg. The Zn concentration in this blank however, was much lower than any concentration found in the sediment composites, consequently, no corrective action was taken. Recoveries for all metals in composite SRP 50 (Boise Cascade) matrix spike ranged from 91% to 105.1%. Recoveries for all metals in composite SRP 14-22 (Port of Wilma) matrix spike ranged from 86.9% to 111.1%. These recoveries were within the QA/QC goal of 75% to 125% established for metals.

Four SRMs (SRM-1, SRM-2, SRM-3, and SRM-4) were analyzed with the Snake and Columbia river sediment samples. These SRMs were within the certified ranges listed in Table 3.7 with the exception of As, Cr, Pb, and Zn for SRM-1; As, Cd, Cr, Zn, and Hg for SRM-2; and As for SRM-4. Because the matrix spike recoveries were within acceptable range, no corrective action was taken for the out-of-range SRM values.

3.5 POLYNUCLEAR AROMATIC HYDROCARBONS

Nineteen sediment composites were analyzed for 18 PAHs. Results of analyses for PAHs are provided in Tables 3.8 and 3.9; results of quality control samples associated with these analyses are shown in Tables 3.10 and 3.11. Nine sediment composites had undetected levels of

TABLE 3.8. Sediment Results for PAH for the Columbia and Snake Rivers Sampling Project (Naphthalene to Anthracene)

Sampling Station	PAHs (ug/kg dry weight)							
	<u>Naphthalene</u>	<u>2-Methyl-naphthalene</u>	<u>Acenaphthylene</u>	<u>Acenaphthene</u>	<u>Dibenzo-furan</u>	<u>Fluorene</u>	<u>Phenanthrene</u>	<u>Anthracene</u>
SRP 1,2	12 U(a)	12 U	12 U	12 U	12 U	12 U	12 U	12 U
SRP 3,4	12 U	11 J(b)	12 U	21	15	18	57	15
SRP 7A	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U
SRP 9	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
SRP 12	4.1 B(c)	2.2	2.1 U	2.1 U	2.1 U	2.7	7.5	2.1 U
SRP 13	33 U	33 U	33 U	33 U	33 U	33 U	33 U	33 U
SRP 23	2.7 B	1.7 J	1.8 U	1.8 U	1.8 U	1.8	5.0	1.7 J
SRP 14-22	27 U	27 U	27 U	27 U	27 U	27 U	27 U	27 U
SRP-24,25	1.4 B	1.3 U	1.3 U	1.7	1.3 U	2.5	6.9	2.6
SRP 26,27	2.5 B	1.4 U	1.4 U	1.4 U	1.4 U	1.6	6.0	1.9
SRP 28,29	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
SRP 30-32	1.8 B	1.2 J	1.2 U	2.8	1.8	2.7	8.6	1.2
SRP 33,34	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U
SRP 33,34 Dup	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U
SRP 50	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U
SRP 51	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U
SRP 52	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	2.5	7.1	11
SRP 53	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	3.1	1.8 U
SRP 54	2.3 B	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	3.4	1.9 U
SRP 55,56	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U

(a) U Analyte was not present above the level of associated value.

(b) J Analyte detected below method detection limits (MDL), but above instrument detection limit (IDL).

(c) B Analyte was found in the blank as well as the sample; indicates possible blank contamination.

TABLE 3.9. Sediment Results for Polynuclear Aromatic Hydrocarbons Results (µg/kg dry weight) for the Columbia and Snake River Sampling Project (Fluoranthene to Benzo(g,h,i)perylene)

Sediment Composite	Fluoranthene	Pyrene	Benzo(a) anthracene	Chrysene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Benzo(a) pyrene	Indeno-(1,2,3-cd) pyrene	Dibenz(a,h) anthracene	Benzo-(ghi) perylene
SRP 1,2	12 U(a)	12 U	12 U	12 U	12 U	12 U	1.1 U	12 U	12 U	12 U
SRP 3,4	42	33	13	19	—(b)	23	13	16 B(c)	14 B	16 B
SRP 7A	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U
SRP 9	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.5 UJ(d)	1.3 U
SRP 12	7.2	7.4	2.6	4.9	—	7.7	3.3	3.6 B	2.1 U	4.7 B
SRP 13	33 U	33 U	33 U	33 U	33 U	33 U	33 U	33 U	33 U	33 U
SRP-23	4.9	4.7	2.8	5.6	—	5.8	2.2	2.0 B	1.8 U	2.6 B
SRP 14-22	27 U	27 U	27 U	27 U	27 U	27 U	27 U	27 U	27 U	27 U
SRP 24,25	14	7.1	4.4	6.1	—	9.8	4.6	2.7 B	1.3 U	3.0 B
SRP 26,27	4.7	3.2	1.4 U	1.8	—	3.3	1.4 U	1.4 JB	1.4 U	1.7 B
SRP-28,29	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.4 M(e)B	1.7 MB	1.5 MB
SRP 30-32	10	6.3	1.3	2.8	—	3.7	1.6	1.4 B	0.8 JB	1.7 B
SRP 33,34	18	22	22	30	—	70	49	43 B	20 B	42 B
SRP 33,34 Dup	22	29	28	36	—	76	57	47 B	20 B	38 B
SRP-50	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U	15 B	14 B
SRP-51	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U	12 U
SRP-52	5.5	4.6	1.6	3.4	—	4.9	2.1	2.1 P	1.6 U	2.5 B
SRP-53	4.3	2.9	1.9 U	3.0	—	4.8	2.1	2.1 B	1.8 U	2.6 B
SRP-54	5.4	4.0	2.2	3.4	—	6.4	3.1	2.7 B	1.9 U	3.0 B
SRP 55,56	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U

(a) U Analyte was not present above the level of the associated value.

(b) — Results reported are for both benzo(a)- and benzo(k)fluoranthene.

(c) B Analyte was found in the blank as well as the sample; indicates possible blank contamination.

(d) J Analyte detected below method detection limits (MDL), but above instrument detection limit (IDL).

(e) M An estimated value of analyte found and confirmed by analyst, but possibly elevated because of background contribution.

TABLE 3.10. Quality Control Data for Polynuclear Aromatic Hydrocarbons (PAH) Results (µg/kg dry weight) (Naphthalene to Pyrene)

Quality Control Methods	Naphthalene	2-Methylnaphthalene	Acenaphthylene	Acenaphthene	Dibenzofuran	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene
<u>Analytical Duplicates</u>										
SRP 33,34	13 U(a)	13 U	13 U	13 U	13 U	13 U	13 U	13 U	18	22
SRP 33, 34 Dup	13 U	13 U	13 U	13 U	13 U	13 U	13 U	13 U	22	29
RPD	0	0	0	0	0	0	0	0	20	27
I-STAT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
<u>Method Blank</u>	0.6 J(b)	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
<u>Matrix Spike</u>										
SRP 50	NS (c)	NS	NS	13 U	NS	13 U	NS	NS	13 U	NS
Amount Spiked	NS	NS	NS	105	NS	105	NS	NS	105	NS
Concentration Recovered	NS	NS	NS	55.2	NS	45.2	NS	NS	50.5	NS
Percent Recovery	NS	NS	NS	52.6%	NS	43.0%	NS	NS	48.1%	NS
Control Limits	NS	NS	NS	40%-120%	NS	ND(d)	NS	NS	ND	NS
<u>Matrix Spike Duplicate</u>										
SRP 50	NS	NS	NS	13 U	NS	13 U	NS	NS	13 U	NS
Amount Spiked	NS	NS	NS	106	NS	106	NS	NS	106	NS
Concentration Recovered	NS	NS	NS	63.1	NS	51.0	NS	NS	56.6	NS
Percent Recovery	NS	NS	NS	59.5%	NS	48.1%	NS	NS	53.4%	NS
Control Limits	NS	NS	NS	40% - 120%	NS	ND	NS	ND	NS	NS

TABLE 3.10. (contd)

Quality Control Methods	Naphthalene	2-Methylnaphthalene	Acenaphthylene	Acenaphthene	Dibenzofuran	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene
<u>Standard Reference Materials</u>										
SRM-3	420 B ^(e)	180	54	58	91	66	480	190	650	770
Certified Value	NA ^(f)	NA	NA	NA	NA	NA	577	202	1220	1080
Range	NA	NA	NA	NA	NA	NA	518-636	160-244	980-1460	880-1280
SQ 1 (Sequim Bay)	77 B	97	45	88	5	55	99	110	67	120
Concentration	81	92	79	111	NA	112	173	124	134	148
Min/Max	43/124	33/170	24/120	37/150	NA	40/150	52/250	32/180	40/190	32/230

-
- (a) U Analyte was not present above the level of the associated value.
 (b) J Analyte detected below method detection limits (MDL), but above instrument detection limit (IDL).
 (c) NS Not spiked.
 (d) ND Not detected.
 (e) B Analyte was found in the blank as well as the sample; indicates possible blank contamination.
 (f) NA Not applicable.

TABLE 3.11. Quality Control Data for Polynuclear Aromatic Hydrocarbons (PAH) Results ($\mu\text{g/kg}$ dry weight)
(Benzo(a)anthracene to Benzo(g,h,i)perylene)

Quality Control Methods	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno-(1,2,3-cd)pyrene	Dibenzo(a,h)anthracene	Benzo-(g,h,i)perylene
<u>Analytical Duplicates</u>								
SRP 33,34	22	30	---(a)	70	49	43 B(b)	20 B	42 B
SRP 33,34 Dup	28	36	—	76	57	47 B	20	38 B
RPD	24	18	NA(c)	8	15	9	0	10
I-STAT	0.1	0.1	NA	0.0	0.1	0.0	0.0	0.1
SRP 50	2.1 J(d)	3.5	—	7.2	6.4	3.6 B	9.8 B	12.0 B
SRP 50 Dup	2.5 U(e)	2.0 J	—	3.6	1.8 J	2.2 JB	5.0 B	5.7 B
RPD	17	55	NA	67	112	48	65	72
I-STAT	0.1	0.3	NA	0.3	0.6	0.2	0.3	0.4
<u>Method Blank</u>	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	0.6 J	0.5 J	0.7 J
<u>Reference Materials</u>								
SRM-3	360	580	—	1200	440	530 B	190 B	500 B
Certified Value	550	NA	780	444	670	569	NA	516
Range	471-629	NA	590-970	395-493	540-800	529-609	NA	433-599
SQ 1 (Sequim Bay)	110	130	110	3 U	110	10 B	120 B	100 B
Average Concentration	127	125	126	—	118	44	102	115
Min./Max.	41/170	32/165	22/210	—	27/233	5/93	22/160	31/180

(a) — Reported results are for both benzo(a)- and benzo(k)fluoranthene.

(b) B Analyte was found in the blank as well as the sample; indicates possible blank contamination.

(c) NA Not applicable.

(d) J Analyte detected below method detection limits (MDL), but above instrument detection limit (IDL).

(e) U Analyte was not present above the level of the associated value.

all 18 PAH compounds. The remaining 10 composites had at least one detectable PAH compound.

Sediment composite SRP 30-32 (Port of Lewiston) had the greatest number of detectable PAH compounds, followed by SRP 3,4 (Port of Kennewick), and SRP 24, 25 (Port of Clarkston):

<u>Designation</u>	<u>Sediment Composite</u>	<u>Number of PAH Compounds</u>
Port of Lewiston	SRP 30-32	12
Port of Kennewick	SRP 3,4	12
RM 131.62	SRP 23	10
Port of Clarkston	SRP 24,25	10

Fluoranthene, pyrene, chrysene, and benzo(b,k)- fluoranthene were the PAH compounds most frequently detected in these sediment composites.

Sediment composite SRP 33,34 (Port of Lewiston) was analyzed in duplicate and produced calculated RPDs ranging from 0% to 27%, which was within the QA/QC goal of $\pm 30\%$ relative precision. Results of the method blank analysis for all 18 PAH compounds were at or below the detection limit for all PAH compounds. (Note that for the PAH analyses, the detection limit was determined for each sediment composite based on the amount of sediment sample used to perform GCMS.) Recoveries of the three spiked compounds (acenaphthene, fluorene, and fluoranthene) ranged from 43% to 52.6% for SRP 50 (Boise Cascade) and from 48.1% to 59.5% in the matrix spike duplicate. Both were within the QA/QC goal of 40% to 120%.

Certified ranges are given for SRM-3 for 10 of the 18 PAH compounds. Of the compounds for which certified values exist phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene were found at concentrations slightly lower than the certified range. One sample, Sequim Bay sediment (SQ-1), was analyzed as a reference material. Average concentrations and minimum/maximum concentrations are available (based on past MSL data) for 16 of the 18 PAH compounds. All of the results for the SQ-1 analysis fell within the previously obtained minimum/maximum values.

3.6 POLYCHLORINATED BIPHENYLS AND CHLORINATED PESTICIDES

Nineteen samples were analyzed for PCBs and chlorinated pesticides. Results of analyses for PCBs are provided in Table 3.12; results of quality control samples associated with these analyses are shown in Table 3.13. Results of analyses for pesticides are provided in Table 3.14 for aldrin through 4,4'-DDT and in Table 3.15 for dieldrin through toxaphene. Quality control samples associated with pesticide analyses are shown in Table 3.16 and 3.17. Surrogate recoveries, which apply to both PCB and pesticide analyses, are shown in Table 3.18.

TABLE 3.12. Sediment Polychlorinated Biphenyls Results for the Columbia and Snake Rivers Sampling Project

<u>Sediment Composite</u>	<u>PCBs (µg/kg dry weight)</u>			
	<u>Aroclor 1242/1016</u>	<u>Aroclor 1248</u>	<u>Aroclor 1254</u>	<u>Aroclor 1260</u>
SRP 1,2	10 U(a)	10 U	10 U	5.6 J(b)
SRP 3,4	10 U	10 U	10 U	10 U
SRP 7A	10 U	10 U	10 U	10 U
SRP 7A dup	10 U	10 U	10 U	10 U
SRP 9	10 U	10 U	10 U	10 U
SRP 12	10 U	10 U	10 U	10 U
SRP 13	10 U	10 U	10 U	10 U
SRP 14-22	10 U	10 U	10 U	10 U
SRP 23	10 U	10 U	10 U	10 U
SRP 24, 25	10 U	10 U	10 U	10 U
SRP 26, 27	10 U	10 U	10 U	20 U
SRP 28, 29	10 U	10 U	10 U	10 U
SRP 30-32	10 U	10 U	10 U	10 U
SRP 33, 34	10 U	10 U	10 U	10 U
SRP 50	10 U	10 U	10 U	11
SRP 51	10 U	10 U	10 U	6.5 J
SRP 52	10 U	10 U	10 U	10 U
SRP 53	10 U	10 U	10 U	10 U
SRP 54	10 U	10 U	10 U	10 U
SRP 55, 56	10 U	10 U	10 U	10 U

(a) U The analyte was not present above the level of the associated value.

(b) J Estimated value when result is less than the specified detection limit.

Concentrations of Aroclor 1242/1016, 1248, and 1254 were undetected in all 19 sediment composites. Concentrations of Aroclor 1260 were found in sediment composites SRP 1,2 (Walla Walla Grain Terminal), and SRP 50, SRP 51 (Boise Cascade) at levels ranging from 5.6 µg/kg to 11 µg/kg.

TABLE 3.13. Quality Control Data for Polychlorinated Biphenyls

Quality Control Methods	PCBs ($\mu\text{g/kg}$ dry weight)			
	Aroclor 1242/1016	Aroclor 1248	Aroclor 1254	Aroclor 1260
Analytical Duplicates				
SRP 7A	10 U ^(a)	10 U	10 U	10 U
SRP 7A dup	10 U	10 U	10 U	10 U
RPD	NA ^(b)	NA	NA	NA
I-Stat	NA	NA	NA	NA
Analytical Blanks				
Blank I	10 U	10 U	10 U	10 U
Blank II	10 U	10 U	10 U	10 U
Blank III	10 U	10 U	10 U	10 U
Blank IV	10 U	10 U	10 U	10 U
Blank V	10 U	10 U	10 U	10 U
Reference Material				
SQ-1		10 U	10 U	9010 U

(a) U The analyte was not present above the level of the associated value.

(b) NA Not applicable for calibrations due to undetected sample concentrations.

Detectable pesticides in the sediment composites included 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT. Concentrations of 4,4'-DDD ranged from 0.9 $\mu\text{g/kg}$ (qualified as below detection limit) to 4.8 $\mu\text{g/kg}$. Concentrations of 4,4'-DDE ranged from 0.6 $\mu\text{g/kg}$ (qualified as below detection limit) to 16 $\mu\text{g/kg}$. Concentrations of 4,4'-DDT ranged from 0.6 $\mu\text{g/kg}$ to 1.8 $\mu\text{g/kg}$ (qualified as below detection limit). For each of the three compounds, sediment composite SRP 52 (RM 119.36) had the highest levels of pesticides followed by sediment composite SRP 12.

For PCB analyses, sediment composite SRP 7A (Port of Burbank) was selected for duplicate analysis and showed no measurable PCB concentrations (all results were below the detection limit); therefore, RPDs could not be determined for the duplicate analysis. All five of the method blanks analyzed for PCBs were undetected at the achieved detection limit of 10 $\mu\text{g/kg}$. Standard reference material SQ-1 had 90 $\mu\text{g/kg}$ PCB as Aroclor. This concentration corresponds closely to the SQ-1 consensus value for total PCB of 108 $\mu\text{g/kg}$.

TABLE 3.14. Sediment Pesticide ($\mu\text{g/kg}$ dry weight) Results for the Columbia and Snake Rivers Sampling Project (Aldrin to - 4,4-DDT)

<u>Sediment Composite</u>	<u>Aldrin</u>	<u>Alpha-BHC</u>	<u>Beta-BHC</u>	<u>Delta-BHC</u>	<u>Gamma-BHC</u>	<u>(Lindane) Chlordane</u>	<u>Alpha Chlordane</u>	<u>Gamma- 4,4'-DDD</u>	<u>4,4'-DDE</u>	<u>4,4'-DDT</u>
SRP 1,2	2.0 U(a)	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.7 J(b)	2.4	2.0 U
SRP 3,4	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.7 J	1.3 J	0.5 J
SRP 7A	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.6 J	0.7 J	2.0 U
SRP 7A dup	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.6 J	0.8 J	2.0 U
SRP 9	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
SRP 12	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0	9.6	1.1 J
SRP 13	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.9 J	5.1	2.0 U
SRP 14-22	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.3 J	2.8	0.6 J
SRP 23	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.9 J	3.4	2.0 U
SRP 24,25	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.0 J	0.6 J	1.2 J
SRP 26,27	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.0 J	3.3	2.0 U
SRP 28,29	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
SRP 30-32	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.7 J	1.7 J	2.0 U
SRP 33,34	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.0 J	2.0 U
SRP 50	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.4 J	0.8 J	2.0 U
SRP 51	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.5 J	2.0	2.0 U

TABLE 3.14. (contd)

<u>Sediment Composite</u>	<u>Aldrin</u>	<u>Alpha-BHC</u>	<u>Beta-BHC</u>	<u>Delta-BHC</u>	(Lindane) <u>Gamma-BHC</u>	<u>Alpha Chlordane</u>	<u>Gamma- Chlordane</u>	<u>4,4'-DDD</u>	<u>4,4'-DDE</u>	<u>4,4'-DDT</u>
SRP 52	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	4.8	16	1.8 J
SRP 53	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.2 J	6.5	2.0 U
SRP 54	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.2 J	7.4	2.0 U
SRP 55,56	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U

(a) U Analyte was not present above the level of the associated value.

(b) J Analyte detected below method detection limits (MDL), but above instrument detection limit (IDL).

TABLE 3.15. Sediment Pesticide ($\mu\text{g/kg}$ dry weight) Results for the Columbia and Snake Rivers Sampling Project (Dieldrin to Toxaphene)

Sediment Composite	Dieldrin	Endrin	Endrin Ketone	Endo-sulfan I	Endo-sulfan II	Endosulfan sulfate	Hepta-chlor	Heptachlor Epoxide	Methoxy-chlor	Toxaphene
SRP 1,2	2.0 U(a)	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 3,4	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 7A	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 7A dup	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 9	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 12	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 13	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 14-22	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 23	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 24,25	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 26,27	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 28,29	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 30-32	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 33,34	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 50	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 51	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U

TABLE 3.15. (contd)

<u>Sediment Composite</u>	<u>Dieldrin</u>	<u>Endrin</u>	<u>Endrin Ketone</u>	<u>Endo- sulfan I</u>	<u>Endo- sulfan II</u>	<u>Endosulfan sulfate</u>	<u>Hepta- chlor</u>	<u>Heptachlor Epoxide</u>	<u>Methoxy- chlor</u>	<u>Toxaphene</u>
SRP 52	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 53	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 54	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
SRP 55,56	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U

(a) U Analyte was not present above the level of the associated value.

TABLE 3.16. Quality Control Data for the Pesticide ($\mu\text{g/kg}$ dry weight) Results (Aldrin to 4,4'-DDT)

Quality Control Methods	Aldrin	Alpha-BHC	Beta-BHC	(Lindane) Delta-BHC	Alpha-Gamma-BHC	Gamma-Chlor-dane	Chlor-dane	4,4'-DDD	4,4'-DDE	4,4'-DDT
<u>Analytical Duplicates</u>										
SRP 7A	2.0 U ^(a)	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.6 J ^(b)	0.7 J	2.0 U
SRP 7A dup	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	0.6 J	0.8 J	2.0 U
RPD	NA ^(c)	NA	NA	NA	NA	NA	NA	0.00%	13.33%	NA
I-Stat	NA	NA	NA	NA	NA	NA	NA	0.00	0.07	NA
<u>Analytical Blanks</u>										
Blank I	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Blank II	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Blank III	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Blank IV	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Blank V	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
<u>Matrix Spikes</u>										
SRP 3,4	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.7 J	1.3 J	0.5 J
SRP 3,4 + MS	2.7	NS ^(d)	NS	NS	2.5	NS	NS	NS	NS	5.0
Amount Spiked	3.1	NS	NS	NS	3.1	NS	NS	NS	NS	6.2
Percent Recovery	87%	NS	NS	NS	81.0%	NS	NS	NS	NS	73%
SRP 3,4	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	1.7 J	1.3 J	0.5 J
SRP 3,4 + MSD	2.6	NS	NS	NS	2.5	NS	NS	NS	NS	4.8
Amount Spiked	3.1	NS	NS	NS	3.1	NS	NS	NS	NS	6.2
Percent Recovery	84%	NS	NS	NS	81.0%	NS	NS	NS	NS	69%

(a) U Analyte was not present above the level of the associated value.

(b) J Analyte detected below method detection limits (MDL), but above instrument detection limit (IDL).

(c) NA Not applicable.

(d) NS Not spiked.

Table 3.17. Quality Control Data for the Pesticide ($\mu\text{g/kg}$ dry weight) Results (Dieldrin to Toxaphene)

Control Methods	Dieldrin	Endrin	Endrin Ketone	Endo- sulfan I	Endo- sulfan II	Endo- sulfan- Sulfate	Hepta- chlor	Hepta- chlor- Epoxide	Methoxy- chlor	Toxa- phene
Analytical Duplicates										
SRP 7A 2.0 U(a)	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U	
SRP 7A dup	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
RPD	NA(b)	NA	NA	NA	NA	NA	NA	NA	NA	NA
I-Stat	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Analytical Blanks										
Blank I	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
Blank II	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
Blank III	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
Blank IV	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
Blank V	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U
Matrix Spikes										
SRP 3,4 2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U	
SRP 3,4 + MS	5.1	5.7	NS(c)	NS	NS	NS	2.3	NS	NS	NS
Amount spiked	6.2	6.2	NS	NS	NS	NS	3.1	NS	NS	NS
Percent Recovery	82%	92%	NS	NS	NS	NS	74%	NS	NS	NS
SRP 3,4 2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	30 U	
SRP 3,4 + MSD	5.0	5.6	NS	NS	NS	NS	2.2	NS	NS	NS
Amount spiked	6.2	6.2	NS	NS	NS	NS	3.1	NS	NS	NS
Percent Recovery	81%	90%	NS	NS	NS	NS	71%	NS	NS	NS

(a) U Analyte was not present above the level of the associated value.

(b) NA Not applicable.

(c) NS Not spiked.

TABLE 3.18. Surrogate Recoveries for Polychlorinated Biphenyls (PCBs) and Chlorinated Pesticides

Sediment Composite	Surrogate Percent Recoveries	
	TCM ^(a)	DCB ^(b)
SRP 1,2	79	102
SRP 3,4	78	92
SRP 7A	63	85
SRP 7A dup	69	94
SRP 9	64	96
SRP 12	86	137
SRP 13	84	104
SRP 14-22	88	88
SRP 23	84	98
SRP 24,25	63	67
SRP 26,27	72	105
SRP 28,29	77	73
SRP 30-32	79	103
SRP 33,34	75	85
SRP 50	68	99
SRP 51	76	101
SRP 52	78	97
SRP 53	78	133
SRP 54	78	96
SRP 55,56	77	82
Blank I	60	95
Blank II	78	92
Blank III	60	95
Blank IV	60	95
Blank V	65	97
SRP 3,4 MS	82	94
SRP 3,4 MSD	83	91
SQ-1 ^(c)	99	74

(a) Tetrachloro-methane.

(b) Dibutylchloredate.

(c) This sediment composite only applies to the PCBs.

For chlorinated pesticides, sediment composite SRP 7A (Port of Burbank) was selected for duplicate analysis and showed no measurable pesticide concentrations for any of the pesticide compounds except 4,4'-DDD and 4,4'-DDE. The RPDs between the duplicate analyses for DDD and DDE were 0% and 13.33%, respectively, which is within QA/QC goal of $\pm 30\%$ established for relative precision. Pesticides concentrations in five of the method blanks analyzed for pesticides were undetected at the achieved detection limits ($2.0 \mu\text{g/kg}$ for all compounds except chlordane, which had a detection limit of $30 \mu\text{g/kg}$). Recovery of the six spiked compounds (aldrin, lindane, 4,4'-DDT, dieldrin, endrin, and heptachlor) ranged from 73% to 92% in the matrix spikes and from 69% to 90% in the matrix spike duplicates. These recoveries were within the QA/QC goal of 40% to 120% indicating acceptable accuracy of the method. The recoveries of the surrogate compounds added to each sample prior to extraction ranged from 67% to 137% for dibutylchloredate (DCB) and from 60% to 99% for tetrachloro-methane (TCM). These surrogate recoveries are within the QA/QC goal of 40% to 120% established for surrogate compounds.

3.7 POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

Eighteen sediment composites were analyzed for polychlorinated dibenzodioxin (PCDD)/polychlorinated dibenzofuran (PCDF) congeners (SRP 9 was sampled for organics and metals only). Sediment composite results are reported as parts per trillion (pptr) and are presented in Table 3.19; quality control samples associated with PCDD/PCDF analyses are presented in Table 3.20. Recoveries results for internal standards are shown in Table 3.21.

Concentrations of 2,3,7,8-TCDD ranged from 0.04 pptr to 0.62 pptr. Concentrations of 2,3,7,8-TCDF ranged from 0.20 pptr to 16.10 pptr. Sediment composite SRP 51 (Boise Cascade) had the highest levels of 2,3,7,8-TCDD/TCDF. The following list summarizes the TCDD/TCDF concentrations for sediment composites with the highest levels:

<u>Sediment Composite</u>	<u>2,3,7,8-TCDD</u>	<u>2,3,7,8-TCDF</u>
SRP 51 (Boise Cascade Mill)	0.62	15.5
SRP 54 (RM 121.8)	0.50	3.12
SRP 50 (Boise Cascade Mill)	0.47	12.1
SRP 53 (RM 120.7)	0.44	4.46
SRP 24,25 (Port of Clarkston)	0.31	0.45

The pentachlorinated congeners of PeCDD and PeCDF ranged from 0.06 pptr to 0.14 pptr, and 0.05 pptr to 0.31 pptr, respectively. Again, SRP 51 (Boise Cascade) had the highest levels of both congeners. The hexachlorinated congeners of HxCDD and HxCDF ranged from 0.09 pptr to 1.66 pptr, and 0.04 pptr to 0.55 pptr, respectively. The heptachlorinated congeners of HpCDD and HpCDF ranged from 1.69 pptr to 27.20 pptr, and 0.07 pptr to 4.00 pptr respectively. Sediment composite SRP 12 (RM 123.3) had the highest levels of heptachlorinated congeners for both TCDD and TCDF. Ranges for OCDD and OCDF were 14.10 pptr to 398 pptr, and 0.83 pptr to 9.49 pptr, respectively.

Five samples were analyzed in duplicate for PCDDs and PCDFs. The RPDs were calculated for each detectable analyte. The EPA Method 8290 recommends that results of laboratory duplicates agree within 25% relative difference. Thirty-nine RPDs were calculated for this set of data, ranging from 1.4% to 77.3%. Fifteen of the 39 RPDs were over the recommended relative difference of 25%.

Low levels of at least one of the PCDD or PCDF congeners were found in each of the method blanks at concentrations ranging from 0.11 to 29.30 pptr. The isomer occurring in the highest concentrations in the blanks was OCDD. The pattern of the blank interference and the recovery of the cleanup standards suggest that blank contamination occurred during the cleanup steps of the procedure. Composites corresponding to a blank having positive results for the other PCDD/PCDF and OCDD/OCDF compounds were qualified as follows. If the PCDD or PCDF congener concentration in the composite was less than five times the concentration of that

TABLE 3.19. Sediment Dioxin and Furan (pptr) Results for the Columbia and Snake Rivers Sampling Project

Analyte	SRP 1.2	SRP 3.4	SRP 7A	SRP 7A dup	SRP 12	SRP 13	SRP 14-22	SRP 23	SRP 24.25	SRP 24.25 dup
<u>Chlorinated Dioxins</u>										
2378-TCDD	0.30	0.18	0.09	0.04	0.47	0.32 U(a)	0.09	0.25	0.10 U	0.31
12378-PeCDD	0.10	0.08 U	0.08 U	0.12	---(b)	—	0.13 U	—	—	—
123478-HxCDD	0.15 U	0.20 U	0.18	0.31	0.46 U	0.49	0.34	0.49	0.57 U	0.54 U
123678-HxCDD	0.58	0.47	0.66	0.87	1.29 U	1.60	1.09 U	1.40	1.66 B(c)	1.47 B
123789-HxCDD	0.52 B	0.54 U	0.65 B	0.82	1.24 U	1.36	1.10	1.21	1.03 B	1.45 B
1234678-HpCDD	4.97	5.00	8.16	10.50	27.20	16.80	10.50	16.70	26.80 B	20.80 B
OCDD	33.3	34.4	84.4	101	398	132	64.5	138	232	179
<u>Chlorinated Furans</u>										
2378-TCDF	7.72	0.44 B	0.20 B	0.29 B	2.59	1.01	0.51	1.28	0.44 U	0.45
12378-PeCDF	0.12 U	0.11 U	0.09 U	0.07	—	0.30 U	0.13 U	0.20 U	—	—
23478-PeCDF	0.19	0.11 U	0.06	0.11 U	—	—	0.18	—	—	—
123478-HxCDF	0.16	0.15	0.17	0.27 B	0.46	0.55	0.34	0.51	0.53	0.46 U
123678-HxCDF	0.10 U	0.10	0.13 U	0.18	0.23 U	0.34	0.21	0.29	0.35 B	0.29 B
234678-HxCDF	0.17	0.19 B	0.29 B	0.27	0.36	0.46	0.39 U	0.43	0.42 B	0.60 UB
123789-HxCDF	0.20 U	0.20 U	0.10 U	0.06 U	0.06 U	0.09 U	0.09 U	0.09 U	0.11 U	0.18 U
1234678-HpCDF	1.24 B	0.85 B	2.50	2.96	4.00	2.83	1.67	2.36	2.97	2.16 B
1234789-HpCDF	0.12	0.09 U	0.14 U	0.20	0.20 U	0.18 U	0.17	0.16 U	0.32	0.27
OCDF	9.49	1.60 B	7.21	6.63	7.75 U	8.60	3.79	6.18	7.30 B	7.55 B

TABLE 3.19. (cont)

Analyte	SRP 26.27	SRP 28.29	SRP 30-32	SRP 30-32 dup	SRP 33.34	SRP 33.34 dup	SRP 50
<u>Chlorinated Dioxins</u>							
2378-TCDD	0.05	0.06 U	0.04 U	0.04 U	0.07 U	0.05 U	0.47
12378-PeCDD	0.09 B	0.15 U	0.06 U	0.06	0.09 U	0.11 U	0.10
123478-HxCDD	0.25 B	0.09	0.07 U	0.06 U	0.07 U	0.12 U	0.32
123678-HxCDD	0.80 B	0.17	0.27	0.29	0.17	0.27	0.47
123789-HxCDD	0.73 B	0.19 U	0.29	0.24 U	0.07 U	0.19 U	0.76 B
1234678-HpCDD	12.1 B	2.15	4.86	3.97	1.69	3.82	6.69 B
OCDD	90.5 B	24.00	34.20	28.80	14.10	21.90	23.60 B
<u>Chlorinated Furans</u>							
2378-TCDF	0.34	0.07 U	0.14	0.15	0.06 U	0.07 U	12.10
12378-PeCDF	0.11	0.08 U	0.06 U	0.05	0.12 U	0.11 U	0.14 U
23478-PeCDF	0.15 U	—	0.06 U	0.06	0.12 U	0.11 U	0.23
123478-HxCDF	0.30	0.08 U	0.10 U	0.11	0.09 U	0.10 U	0.12 U
123678-HxCDF	0.18 UB	0.08 U	0.04	0.08 U	0.08 U	0.07 U	0.07 U
234678-HxCDF	0.24 B	0.11 U	0.19	0.22	0.15	0.18	0.18 U
123789-HxCDF	0.20 U	0.08 U	0.03 U	0.03 U	0.10 U	0.07 U	0.2 U
1234678-HpCDF	1.29 B	0.18	0.72	0.66	0.39	0.65	0.66 B
1234789-HpCDF	0.12	0.05 U	0.07	0.06 U	0.07 U	0.08 U	0.11 U
OCDF	3.30 B	0.83	1.98	1.63	0.86	1.04	2.76 B

TABLE 3.19. (contd)

Analyte	<u>SRP 51</u>	<u>SRP 51 dup</u>	<u>SRP 52</u>	<u>SRP 53</u>	<u>SRP 54</u>	<u>SRP 55.56</u>
<u>Chlorinated Dioxins</u>						
2378-TCDD	0.62	0.74 U	0.34 U	0.44	0.50	0.06 U
12378-PeCDD	0.17 U	0.14	0.12 U	0.19 U	—	0.10 U
123478-HxCDD	0.34 U	—	0.18	0.24	0.26	0.08 U
123678-HxCDD	0.79 U	—	0.62	0.92 U	1.14 E ^(d)	0.13
123789-HxCDD	0.54	0.93	0.50 U	0.65 U	0.76 U	0.12 U
1234678-HpCDD	6.47	6.21	10.90	16.50	17.10	1.83 B
OCDD	36.60	36.10	81.90	121.00	165.00	14.60 B
<u>Chlorinated Furans</u>						
2378-TCDF	15.50	16.10	3.92	4.46	3.21	0.38
12378-PeCDF	0.25	0.31	0.22 U	0.28	—	0.08 U
23478-PeCDF	0.36 U	0.34 U	0.20	0.24 U	—	0.08 U
123478-HxCDF	0.28	0.30	0.27 U	0.35	0.39	0.07 U
123678-HxCDF	0.42 U	0.31 U	0.16	0.18	0.20 U	0.07 U
234678-HxCDF	0.42 U	0.31 U	0.33	0.36	0.40	0.18
123789-HxCDF	0.14 U	0.22 U	0.06	0.10 U	0.12 U	0.07
1234678-HpCDF	1.39	1.63	1.55	2.44	2.60	0.23 B
1234789-HpCDF	0.16	0.18 U	0.18	0.22	0.13 U	0.09 U
OCDF	8.55	8.84	4.86	7.85	9.06	0.67 UB

(a) U Analyte was not present above the level of the associated value.

(b) — Matrix interference caused peaks to co-elute. Concentrations could not be calculated.

(c) B Analyte was found in the blank as well as in the sample; indicates possible blank contamination.

(d) E Value is an estimate; analyte not detected on confirmation column.

Table 3.20. Quality Control Data for the Dioxin/Furan (pptr) Results

Analyte	SRP 7A	SRP 7A dup	RPD	I-STAT	SRP 24.25	SRP 24.25 dup	RPD	I-STAT
<u>Chlorinated Dioxins</u>								
2378-TCDD	0.09	0.04	76.9%	0.39	0.10 U(a)	0.31 U	NA(b)	NA
12378-PeCDD	0.08 U	0.12	NA	NA	*(c)	*	NA	NA
123478-HxCDD	0.18	0.31	53.1%	0.27	0.57 U	0.54 U	NA	NA
123678-HxCDD	0.66	0.87	27.5%	0.14	1.66	1.47	12.1%	0.06
123789-HxCDD	0.65	0.82	23.1%	0.12	1.03	1.45	33.9%	0.17
1234678-HpCDD	8.16	10.50	25.1%	0.13	26.80	20.80	25.2%	0.13
OCDD	84.40	101.00	17.9%	0.09	232.00	179.00	25.8%	0.13
<u>Chlorinated Furans</u>								
2378-TCDF	0.20	0.29	36.7%	0.18	0.44 U	0.45	NA	NA
12378-PeCDF	0.09 U	0.07	NA	NA	*	*	NA	NA
23478-PeCDF	0.06	0.11 U	NA	NA	*	*	NA	NA
123478-HxCDF	0.17	0.27	45.5%	0.23	0.53	0.46 U	NA	NA
123678-HxCDF	0.13 U	0.18	NA	NA	0.35	0.29	18.8%	0.09
234678-HxCDF	0.29	0.27	7.1%	0.04	0.42	0.60 U	NA	NA
123789-HxCDF	0.10 U	0.06 U	NA	NA	0.11 U	0.18 U	NA	NA
1234678-HpCDF	2.50	2.96	16.9%	0.08	2.97	2.16	31.6%	0.16
1234789-HpCDF	0.14 U	0.20	NA	NA	0.32	0.27	16.7%	0.09
OCDF	7.21	6.63	8.4%	0.04	7.30	7.55	3.4%	0.02

Table 3.20. (contd)

Analyte	SRP 30-32	SRP 30-32 dup	RPD	I-STAT	SRP 33.34	SRP 33.34 dup	RPD	I-STAT	SRP 51	SRP 51 dup	RPD	I-STAT
<u>Chlorinated Dioxins</u>												
2378-TCDD	0.04 U	0.04 U	NA	NA	0.07 U	0.05 U	NA	NA	0.62	0.74 U	NA	NA
12378-PeCDD	0.06 U	0.06	NA	NA	0.09 U	0.11 U	NA	NA	0.17 U	0.14	NA	NA
123478-HxCDD	0.07 U	0.06 U	NA	NA	0.07 U	0.12 U	NA	NA	0.34 U	*	NA	NA
123678-HxCDD	0.27	0.29	7.1%	0.04	0.17	0.27	45.5%	0.23	0.79 U	*	NA	NA
123789-HxCDD	0.29	0.24 U	NA	NA	0.07 U	0.19 U	NA	NA	0.54	0.93	53.1%	0.27
1234678-HpCDD	4.86	3.97	20.2%	0.10	1.69	3.82	77.3%	0.39	6.47	6.21	4.1%	0.02
OCDD	34.20	28.80	17.1%	0.09	14.10	21.90	43.3%	0.22	36.60	36.10	1.4%	0.01
<u>Chlorinated Furans</u>												
2378-TCDF	0.14	0.15	6.9%	0.03	0.06 U	0.07 U	NA	NA	15.50	16.10	3.8%	0.02
12378-PeCDF	0.06 U	0.05	NA	NA	0.12 U	0.11 U	NA	NA	0.25	0.31	21.4%	0.11
23478-PeCDF	0.06 U	0.06	NA	NA	0.12 U	0.11 U	NA	NA	0.36 U	0.34 U	NA	NA
123478-HxCDF	0.10 U	0.11	NA	NA	0.09 U	0.10	NA	NA	0.28	0.30	6.9%	0.03
123678-HxCDF	0.04	0.08 U	NA	NA	0.08 U	0.07	NA	NA	0.13 U	0.20 U	NA	NA
234678-HxCDF	0.19	0.22	14.6%	0.07	0.15	0.18	18.2%	0.09	0.42 U	0.31 U	NA	NA
123789-HxCDF	0.03 U	0.03 U	NA	NA	0.10 U	0.07 U	NA	NA	0.14 U	0.22 U	NA	NA
1234678-HpCDF	0.72	0.66	8.7%	0.04	0.39	0.65	50.0%	0.25	1.39	1.63	15.9	0.08
1234789-HpCDF	0.07	0.06 U	NA	NA	0.07 U	0.08 U	NA	NA	0.16	0.18 U	NA	NA
OCDF	1.98	1.63	19.4%	0.10	0.86	1.04	18.9%	0.10	8.55	8.84	3.3%	0.02

TABLE 3.20. (contd)

Analyte	Blank I	Blank II	Blank III	Blank IV	Blank V
<u>Chlorinated Dioxins</u>					
2378-TCDD	0.4 U	0.14 U	0.26 U	0.46 U	0.11 U
12378-PeCDD	0.6 U	0.23 U	0.23 U	0.21 U	0.90
123478-HxCDD	0.53 U	0.20 U	0.22 U	0.34 U	0.19 U
123678-HxCDD	0.18 U	0.20 U	0.22 U	0.26 U	1.08
123789-HxCDD	0.16	0.83 U	0.16 U	0.20 U	0.49
1234678-HpCDD	1.41	0.46 U	0.51	0.93 U	9.32
OCDD	5.61	2.13	3.55	3.73 E(d)	29.30
<u>Chlorinated Furans</u>					
2378-TCDF	0.11	0.13 U	0.15 U	0.26 U	0.22 U
12378-PeCDF	0.31 U	0.20 U	0.22 U	0.28 U	0.13 U
23478-PeCDF	0.30 U	0.16 U	0.21 U	0.28 U	0.13 U
123478-HxCDF	0.4 U	0.13 U	0.18 U	0.22 U	0.21 U
123678-HxCDF	0.4 U	0.12 U	0.18 U	0.26 U	0.08
234678-HxCDF	0.27	0.35 U	0.41	0.34 U	0.45
123789-HxCDF	0.53 U	0.13 U	0.18 U	0.38 U	0.37 U
1234678-HpCDF	0.36	0.14 U	0.20	2.01 E	0.56
1234789-HpCDF	0.23 U	0.26 U	0.18 U	0.4 U	0.16 U
OCDF	0.68	0.6 U	0.32	0.55 U	2.2

(a) U Analyte was not present above the level of the associated value.

(b) NA Not applicable.

(c) * Matrix interference caused peaks to co-elute. Concentrations could not be calculated.

(d) E Estimated concentration, analyte was detected but did not pass all QA criteria.

TABLE 3.21. Internal Standard Results for the Dioxin/Furan (%) Samples

Analyte	SRP 1.2	SRP 3.4	SRP 7A	SRP 7A dup	SRP 12	SRP 13	SRP 14-22	SRP 23	SRP 24.25	SRP 24.25 dup
<u>Internal Standards</u>										
2378-TCDD-C13	72	80	78	76	70	77	82	78	79	68
12378-PeCDD-C13	85	95	94	90	53	58	109	56	---(a)	—
123478-HxCDD-C13	77	80	75	77	71	78	77	76	85	70
123678-HxCDD-C13	76	78	66	81	69	77	74	77	77	70
1234678-HpCDD-C13	92	92	80	94	92	100	104	104	117	102
OCDD-C13	103	91	78	91	93	100	101	106	126	101
2378-TCDF-C13	69	77	76	74	73	81	83	80	79	70
12378-PeCDF-C13	58	63	65	63	47	75	85	75	—	—
23478-PeCDF-C13	58	69	65	62	43	46	88	46	—	—
123478-HxCDF-C13	67	66	61	66	62	72	71	72	91	81
123678-HxCDF-C13	62	62	59	82	59	69	67	67	80	76
123789-HxCDF-C13	66	66	59	64	62	75	73	74	92	77
234678-HxCDF-C13	76	75	72	75	74	85	88	85	103	94
1234678-HpCDF-C13	72	71	61	71	67	81	86	85	105	99
1234789-HpCDF-C13	86	84	75	79	84	103	106	104	134	123
<u>Cleanup Recovery Standards</u>										
2378-TCDD-C137	74	86	85	77	81	96	102	93	92	78

TABLE 3.21. (contd)

Analyte	SRP 26.27	SRP 28.29	SRP 30-32	SRP 30-32 dup	SRP 33.34	SRP 33.34 dup	SRP 50	SRP 51	SRP 51 dup
<u>Internal Standards</u>									
2378-TCDD-C13	69	75	50	66	78	77	76	65	48
12378-PeCDD-C13	78	104	67	87	103	103	91	78	61
123478-HxCDD-C13	70	78	53	66	77	80	72	58	61
123678-HxCDD-C13	71	77	54	70	80	78	80	64	41
1234678-HpCDD-C13	83	102	62	79	98	103	100	68	55
OCDD-C13	84	100	56	72	95	103	118	58	43
2378-TCDF-C13	68	79	51	67	82	81	73	68	48
12378-PeCDF-C13	56	75	50	65	76	73	62	59	45
23478-PeCDF-C13	57	18	51	66	79	77	61	59	46
123478-HxCDF-C13	59	71	51	66	69	70	69	60	49
123678-HxCDF-C13	60	67	53	64	69	66	67	60	47
123789-HxCDF-C13	58	70	50	63	67	68	70	54	42
234678-HxCDF-C13	70	85	59	77	80	82	81	71	56
1234678-HpCDF-C13	64	82	54	69	77	76	80	57	43
1234789-HpCDF-C13	76	100	67	87	94	95	92	73	55
<u>Cleanup Recovery Standards</u>									
2378-TCDD-C137	82	89	59	73	90	90	82	82	57

TABLE 3.21. (contd)

Analyte	SRP 52	SRP 53	SRP 54 ^(b)	SRP 55.56	Blank I	Blank II	Blank III	Blank IV	Blank V
<u>Internal Standards</u>									
2378-TCDD-C13	69	53	70	68	74	62	69	70	73
12378-PeCDD-C13	85	67	---	81	85	74	85	88	76
123478-HxCDD-C13	67	54	62	64	73	62	61	70	76
123678-HxCDD-C13	72	57	77	77	84	75	75	84	87
1234678-HpCDD-C13	80	63	60	79	99	84	81	87	87
OCDD-C13	75	63	39	76	95	56	77	76	76
2378-TCDF-C13	71	54	88	71	69	66	70	70	73
12378-PeCDF-C13	65	51	---	63	59	62	63	65	61
23478-PeCDF-C13	66	50	---	64	58	62	64	66	59
123478-HxCDF-C13	65	55	71	64	69	67	59	77	72
123678-HxCDF-C13	67	53	75	70	70	73	66	82	73
123789-HxCDF-C13	64	52	65	63	69	68	59	66	67
234678-HxCDF-C13	74	59	69	71	80	72	68	91	76
1234678-HpCDF-C13	71	57	59	70	78	69	70	80	68
1234789-HpCDF-C13	84	69	60	84	92	66	83	93	78
<u>Cleanup Recovery Standards</u>									
2378-TCDD-C137	78	60	83	74	84	78	79	78	86

- (a) --- Matrix interference in the penta channels prevented positive internal standard identification.
 (b) Sample may have been improperly spiked with recovery standard.

congener found in the blank, the composite concentration was flagged with a "B" to indicate that the PCDD or PCDF compound was also present in the blank.

Recovery of the 16 surrogate PCDD/PCDF congeners that were added to each composite as internal standards ranged from 18% to 134%. These recoveries indicated excellent sample extraction efficiency, within the EPA-recommended range of 40% to 135%. Recovery of the cleanup standards ranged from 57% to 102%, which was within the EPA recommended range of 40% to 135%.

3.8 RESULTS FOR SEDIMENT COMPOSITE RM 119.56

River Mile 119.56 is currently being considered as an in-water disposal site. A sediment sample was not collected from the proposed disposal site during this study because an archived sediment sample from this site had already been collected in October 1990 (Pinza et al. 1991). The previous study had already reported grain size, TOC, and dioxins/furans concentrations of sediment from RM 119.56. For this study, the archived sample was submitted for additional chemical analyses including TOC, TVS, oil and grease, TPH, metals, PAHs, PCBs, and pesticides. Because the archived sample was a combination of ponar and Van Veen grab samples, the additional analyses are reported as a "composite" whereas the previous analyses of grain size, TOC, and dioxins/furans are reported as either "ponar" or "Van Veen" (RM 119.56 P or V) in Tables 3.22 through 3.30.

3.8.1 Grain Size

Results of grain size analysis from the October 1990 sampling effort are presented in Table 3.22. Based on the Van Veen samples, sediment at RM 119.56 consisted mainly of silt (63.18%). The ponar sample had about equal amounts of silt (44.62%) and sand (43.12%).

3.8.2 Total Organic Carbon

Results of the TOC analyses and associated quality control samples for the composite sample analysis are presented in Table 3.22. Total organic carbon concentrations for samples RM 119.56V and RM 119.56P were 2.34% and 1.79%, respectively. The combined composite of RM 119.56V and RM 119.56P had a TOC concentration of 3.12%.

Composite RM 119.56 was analyzed in duplicate and had a RPD of 5.9%, which was within the QA/QC goal of $\pm 10\%$ relative precision. Concentrations of TOC in the method blank were undetected at a detection limit of 0.0285%. The matrix spike recovery was 95.11%.

3.8.3 Total Volatile Solids

Total volatile solids in the composite RM 119.56 sample was 6.08%. Duplicate analysis of the composite sample had a RPD of 10%, which was within the QA/QC goal of $\pm 10\%$ relative precision.

TABLE 3.22. Sediment Conventional Results for Sampling Station RM 119.56

Sediment Composite	% Grain Size				TOC %	TVS %	Oil and Grease mg/kg	TPH mg/kg
	Gravel	Sand	Silt	Clay				
RM 119.56V	0.02	19.39	63.81	16.78	2.34	NA(a)	NA	NA
RM 119.56P	0.06	43.12	44.62	12.2	1.79	NA	NA	NA
Composite(b)	NA	NA	NA	NA	3.12	6.08	1095(c)	63
<u>Quality Control Data</u>								
<u>Analytical Duplicates</u>								
Composite Rep 1	NA	NA	NA	NA	3.12	6.08	1095(c)	NA
Rep 2	NA	NA	NA	NA	3.31	6.73	953(c)	NA
RPD	NA	NA	NA	NA	5.9	10.1	13.9	NA
I-STAT	NA	NA	NA	NA	0.03	0.05	0.07	NA
<u>Method Blanks</u>	NA	NA	NA	NA	0.0285 U(d)	NA	46	10 U
<u>Matrix Spike Analysis/Matrix Spike Duplicate</u>								
Composite	NS(e)	NS	NS	NS	3.12	NS	1095	63
Amount Spiked	NS	NS	NS	NS	1.06	NS	7080	50
Concentration								
Recovered	NS	NS	NS	NS	4.14	NS	8407	137
Percent Recovery	NS	NS	NS	NS	95.11	NS	103.28	147
Composite	NS	NS	NS	NS	NS	NS	NS	63
Amount Spiked	NS	NS	NS	NS	NS	NS	NS	50
Concentration								
Recovered	NS	NS	NS	NS	NS	NS	NS	123
Percent Recovery	NS	NS	NS	NS	NS	NS	NS	120

(a) NA Not Applicable

(b) Composite of RM 119.56 V and RM 119.56 P

(c) Value seems inordinately high. Data were verified.

(d) U Analyte was not present above the level of the associated value.

(e) NS Not spiked

3.8.4 Oil and Grease and Total Petroleum Hydrocarbons

Oil and grease and TPH quality control results for the composite sample analysis are shown in Table 3.22. Oil and grease and TPH results for the composite RM 119.56 were 1095 mg/kg and 63 mg/kg, respectively.

The concentration of TPH in the method blank was undetectable at the achieved detection limit of 10 mg/kg. For TPH analyses, matrix spike and the matrix spike duplicate recoveries were 147% and 120%, respectively, both within the QA/QC goal of 50% to 150%. Duplicate analysis of the composite sample for oil and grease had a RPD of 13.9% and an I-STAT of 0.07, which was within the QA/QC goal of $\pm 20\%$ relative precision. The concentration of oil and grease in the method blank was 46 mg/kg. The matrix spike recovery was 103.28%, which was within the QA/QC goal of 50% to 150%.

3.8.5 Metals

Results of metals analyses and quality control sample analyses are shown in Table 3.23. Metals analyses were performed for the composite sample of RM 119.56, exclusively. Arsenic, Cd, and Cr concentrations were 6.14, 0.3 (undetected at the detection limit), and 19.8 mg/kg, respectively. Copper, Pb, Hg, and Zn concentrations were 31.1 mg/kg, 13.7 mg/kg, 0.12 mg/kg, and 71.6 mg/kg, respectively.

The composite sample was analyzed in duplicate for each metal to assess precision. The RPDs between the duplicate analyses were within the QA/QC goal of $\pm 20\%$ set for precision. Metals concentrations in the blank sample were undetectable at method detection limits for all metals except Zn, which was found at 7 mg/kg. The matrix spike recoveries ranged from 90.6% to 109.2% which were within the QA/QC goal of 40% to 120%.

3.8.6 Polynuclear Aromatic Hydrocarbons

Results of PAH and quality control analyses for PAHs are shown in Tables 3.24 through 3.26. For the composite of RM 119.56, concentrations of two PAHs (acenaphthylene and acenaphthene) were undetected below the MDL at 1.2 $\mu\text{g/kg}$. The remaining PAH compounds ranged from 1.2 $\mu\text{g/kg}$ (anthracene) to 8.7 $\mu\text{g/kg}$ (benzo(b,k)fluoranthene).

Results of the method blank analysis for all 18 PAH compounds were below the detection limit for each compound in that sample. For the PAH analyses, the detection limit was determined for each compound based on the amount of sediment required for QC analysis. Recovery of three spiked compounds (acenaphthene, fluorene, and fluoranthene) ranged from 33.9% to 52.1% in the matrix spike and from 33.2% to 51.2% in the matrix spike duplicate. These recovery ranges were within QA/QC goal of 40% to 120%.

TABLE 3.23. Sediment Metals Results for Sediment Composite RM 119.56

Sediment Composite	Metals (mg/kg dry weight)						
	As	Cd	Cr	Cu	Pb	Hg	Zn
<u>Analytical Duplicates</u>							
Composite(a)	Rep 1	6.14	0.3 U(b)	19.8	31.1	13.7	71.6
	Rep 2	6.47	0.3 U	20.2	30.7	13.5	77.4
RPD I-STAT		5.2	0.0	2.0	1.3	1.5	8.0
		0.03	0.0	0.01	0.006	0.007	0.04
Method Blank		0.1 U	0.2 U	0.5 U	0.6	0.1 U	7.0
<u>Matrix Spike</u>							
Composite Amount Spiked		6.14	0.03 U	19.8	31.1	13.7	71.6
		15.5	16.6	41.6	16.6	15.5	83.2
Concentration Recovered		20.3	14.9	59.1	47.9	30	147
		91.4	89.8	94.5	101.2	105.2	90.6

(a) Composite sample from RM 119.56 V and RM 119.56 P

(b) U The analyte was not present above the level of the associated value.

3.8.7 Polychlorinated Biphenyls and Pesticides

Results of PCB analysis for composite RM 119.56, as well as associated quality control data, are shown in Table 3.27. Pesticide results and quality control data for this composite are shown in Tables 3.28 and 3.29. The PCBs were undetected in RM 119.56 composite for all compounds except Aroclor 1254, which had a concentration of 5.1 µg/kg (qualified as below detection limit). Pesticides were undetected except for 4,4'-DDE (6.8 µg/kg) and 4,4'-DDT (0.4 µg/kg qualified as below detection limit).

Pesticides were undetected in the method blank for each compound in that sample. (Note that for the pesticide analyses, the detection limit was determined for each compound based on the amount of sediment required for GC analyses.) A matrix spike and matrix spike duplicate were created for chlorinated pesticides by spiking aliquots of the composite sample with the three compounds, lindane, heptachlor, and aldrin. Recoveries of the spiked compounds were all within the target recovery range for each compound. Two surrogate compounds, decachlorobiphenyl and tetrachloro-m-xylene, were added to the samples during processing to assess extraction efficiency. These surrogate compounds were recovered at 97% and 76%, respectively, which is within the QA/QC goal of 10% to 120% indicating acceptable efficiency of extraction.

Two surrogate compounds, d₁₄-p-terphenyl and d₁₀-diphenyl, were added to the samples during processing to assess extraction efficiency. These were recovered at acceptable QA/QC levels of 50.2% and 58.8%, respectively.

TABLE 3.24. Sediment Polynuclear Aromatic Hydrocarbon (PAH) Results (µg/kg dry weight) for Sampling Station RM 119.56 (Naphthalene to Phenanthrene)

<u>Sediment Composite</u>	<u>Naphthalene</u>	<u>2-Methyl-naphthalene</u>	<u>Acenaph-thylene</u>	<u>Acenaph-thene</u>	<u>Dibenzo-furan</u>	<u>Fluorene</u>	<u>Phena-threne</u>
Composite(a)	4.3	2.0	1.2 U(b)	1.2 U	1.6	2.2	7.8
<u>Quality Control Data</u>							
<u>Method Blank</u>	2.0 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	1.3 U
<u>Matrix Spike</u>							
Composite	NS(c)	NS	NS	1.2 U	NS	2.2	NS
Amount Spiked	NS	NS	NS	155	NS	155	NS
Concentration							
Recovered	NS	NS	NS	81	NS	55	NS
Percent Recovery	NS	NS	NS	52.1	NS	33.9	NS
<u>Matrix Spike Duplicate</u>							
Composite	NS	NS	NS	1.2 U	NS	2.2	NS
Amount Spiked	NS	NS	NS	155	NS	155	NS
Concentration							
Recovered	NS	NS	NS	79	NS	54	NS
Percent Recovery	NS	NS	NS	51.2	NS	33.2	NS
<u>Surrogate Percent Recoveries</u>			<u>d14-p-Terphenyl</u>		<u>d10-Diphenyl</u>		
Composite			50.2%		58.8%		

(a) Composite of RM 119.56 V and RM 119.56 P.

(b) U Analyte was not present above the level of the associated value.

(c) NS Not Spiked.

TABLE 3.25. Sediment Polynuclear Aromatic Hydrocarbon (PAH) Results ($\mu\text{g/kg}$ dry weight) for Sampling Station RM 119.56 (Anthracene to Benzo(a)pyrene)

<u>Sediment Composite</u>	<u>Anthracene</u>	<u>Fluoranthene</u>	<u>Pyrene</u>	<u>Benzo(a)anthracene</u>	<u>Chrysene</u>	<u>Benzo(b,k)fluoranthene</u>	<u>Benzo(a)pyrene</u>
Composite(a)	1.2	8.4	5.8	2.7	5.5	8.7	3.3
<u>Quality Control Data</u>							
<u>Method Blank</u>	0.7 U(b)	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U	0.7 U
<u>Matrix Spike</u>							
Composite	NS(c)	8.4	NS	NS	NS	NS	NS
Amount Spiked	NS	155	NS	NS	NS	NS	NS
Concentration	NS		NS	NS	NS	NS	NS
Recovered	NS	84	NS	NS	NS	NS	NS
Percent Recovery	NS	48.5	NS	NS	NS	NS	NS
<u>Matrix Spike Duplicate</u>							
Composite	NS	8.4	NS	NS	NS	NS	NS
Amount Spiked	NS	155	NS	NS	NS	NS	NS
Concentration	NS		NS	NS	NS	NS	NS
Recovered	NS	83	NS	NS	NS	NS	NS
Percent Recovery	NS	48.1	NS	NS	NS	NS	NS

(a) Composite of RM 119.56 V and RM 119.56 P.

(b) U Analyte was not present above the level of the associated value.

(c) NS Not Spiked.

TABLE 3.26. Sediment Polynuclear Aromatic Hydrocarbon (PAH) Results ($\mu\text{g/kg}$ dry weight) for Sampling Station RM 119.56 (Indeno(1,2,3)pyrene to Benzo(ghi)perylene)

<u>Sediment Composite</u>	<u>Indeno(1,2,3) Pyrene</u>	<u>Dibenzo(a,h) Anthracene</u>	<u>Benzo(ghi) Perylene</u>
Composite(a)	4.0	1.4	2.9
<u>Quality Control Data</u>			
<u>Method Blank</u>	0.7 U(b)	0.7 U	0.7 U
<u>Matrix Spike</u>			
Composite	NS(c)	NS	NS
Amount Spiked	NS	NS	NS
Concentration	NS	NS	NS
Recovered	NS	NS	NS
Percent Recovery	NS	NS	NS
<u>Matrix Spike Duplicate</u>			
Composite	NS	NS	NS
Amount Spiked	NS	NS	NS
Concentration	NS	NS	NS
Recovered	NS	NS	NS
Percent Recovery	NS	NS	NS

(a) Composite of RM 119.56 V and RM 119.56 P

(b) U Analyte was not present above the level of the associated value.

(c) NS Not spiked

Table 3.27. Sediment Polychlorinated Biphenyls Results for Sediment Composite RM 119.56

<u>Sediment Composite</u>	<u>PCBs (µg/kg dry weight)</u>			
	<u>Aroclor 1242/1016</u>	<u>Aroclor 1248</u>	<u>Aroclor 1254</u>	<u>Aroclor 1260</u>
Composite(a)	8.0 U(b)	8.0 U	5.1 J(c)	8.0 U

Surrogate Percent Recoveries

	<u>Decachlorobiphenyl</u>	<u>Tetachloro-m-xylene</u>
Composite	97%	76%

- (a) Composite of RM 119.56 V and RM 119.56 P
 (b) U The analyte was not present above the level of the associated value.
 (c) J Estimated value when the result is less than the specified detection limit

3.8.8 Dioxins/Furans

Table 3.30 shows results of the analysis of RM 119.56 V for PCDD/PCDF compounds. Recovery of internal standards and results of quality control samples associated with RM 119.56 are shown in Tables 3.31 and 3.32, respectively. Composite RM 119.56 had undetected levels of 2,3,7,8-TCDD, PeCDDs, and HxCDDs. The heptachlorinated and octachlorinated congener concentrations were 14.0 pptr and 98.0 pptr, respectively. The composite concentration of 2,3,7,8-TCDF was 5.6 pptr. The penta-, hexa-, hepta-, and octachlorinated congeners had maximum concentrations of 0.42 pptr, 0.93 pptr, 2.50 pptr, and 5.70 pptr, respectively.

Recoveries for internal standards ranged from 27% to 130%, which is the EPA-recommended range of 40% to 120% with the exception of one analyte. Recoveries of PCDD/PCDF compounds from a spiked blank, and a matrix spike/matrix spike duplicate also showed excellent extraction efficiency, ranging from 93% to 120%. These recoveries were within the EPA-recommended range of 40% to 120%.

TABLE 3.28. Sediment Pesticide Results (µg/kg dry weight) for Sampling Station RM 119.56 (Alpha-BHC to Dieldrin)

<u>Sediment Composite</u>	<u>Alpha-BHC</u>	<u>Beta-BHC</u>	<u>Delta-BHC</u>	<u>Lindane Gamma-BHC</u>	<u>Heptachlor</u>	<u>Aldrin</u>	<u>Heptachlor Epoxide</u>	<u>Endo-sulfan I</u>	<u>Dieldrin</u>
Composite(a)	0.4 U(b)	0.4 U	0.6 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U
<u>Quality Control Data</u>									
<u>Method Blank</u>	0.4 U	0.4 U	0.6 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U
<u>Matrix Spike Composite</u>	NS(c)	NS	NS	0.4 U	0.4 U	0.4 U	NS	NS	0.8 U
Amount Spiked	NS	NS	NS	4.7	4.7	4.7	NS	NS	9.3
Concentration									
Recovered Percent	NS	NS	NS	3.8	3.5	4.2	NS	NS	7.3
Recovery	NS	NS	NS	81	74	89	NS	NS	78
QC Limits	NS	NS	NS	46-127	35-130	34-132	NS	NS	34-134
<u>Matrix Spike Duplicate</u>									
Composite	NS	NS	NS	0.4 U	0.4 U	0.4 U	NS	NS	0.8 U
Amount Spiked	NS	NS	NS	4.7	4.7	4.7	NS	NS	9.3
Concentration									
Recovered Percent	NS	NS	NS	3.8	3.5	4.1	NS	NS	7.3
Recovery	NS	NS	NS	81	74	87	NS	NS	78
QC Limits	NS	NS	NS	46-127	35-130	34-132	NS	NS	31-134
<u>Surrogate Percent Recoveries</u>				<u>Decachlorobiphenyl</u>		<u>Tetrachloro-m-xylene</u>			
Composite				97%		76%			

(a) Composite of RM 119.56 V and RM 119.56 P

(b) U Analyte was not present above the level of the associated value.

(c) NS Not Spiked

TABLE 3.29. Sediment Pesticide Results ($\mu\text{g/kg}$ dry weight) for Sampling Station RM 119.56 (4,4'-DDD to Toxaphene)

<u>Sediment Composite</u>	<u>4,4'-DDD</u>	<u>4,4'-DDE</u>	<u>Endrin</u>	<u>Endo-sulfan Sulfate</u>	<u>Endo-sulfan II</u>	<u>4,4'-DDT</u>	<u>Methoxy-chlor</u>	<u>Endrin Ketone</u>	<u>Alpha-Chlor-dane</u>	<u>Gamma-Chlor-dane</u>	<u>Toxa-phene</u>
Composite(a)	1.3 U(b)	6.8	0.8 U	1.6 U	0.8 U	0.4 J(c)	1.6 U	1.2 U	0.6 U	0.6 U	60 U
<u>Quality Control Data</u>											
<u>Method Blank</u>	0.8 U	0.8 U	0.8 U	1.6 U	0.8 U	0.8 U	1.6 U	1.2 U	0.6 U	0.6 U	60 U
<u>Matrix Spike</u>											
Composite	NS(d)	NS	0.8 U	NS	NS	0.4 J	NS	NS	NS	NS	NS
Amount Spiked	NS	NS	9.3	NS	NS	9.3	NS	NS	NS	NS	NS
Concentration Recovered Percent	NS	NS	8.5	NS	NS	11	NS	NS	NS	NS	NS
Recovery	NS	NS	91	NS	NS	114	NS	NS	NS	NS	NS
QC Limits	NS	NS	42-139	NS	NS	23-134	NS	NS	NS	NS	NS
<u>Matrix Spike Duplicate</u>											
Composite	NS	NS	0.8 U	NS	NS	0.4 U	NS	NS	NS	NS	NS
Amount Spiked	NS	NS	9.3	NS	NS	9.3	NS	NS	NS	NS	NS
Concentration Recovered Percent	NS	NS	8.3	NS	NS	9.9	NS	NS	NS	NS	NS
Recovery	NS	NS	89	NS	NS	102	NS	NS	NS	NS	NS
QC Limits	NS	NS	42-139	NS	NS	23-134	NS	NS	NS	NS	NS

(a) Composite of RM 119.56V and RM 119.56P

(b) U Analyte was not present above the level of the associated value.

(c) J Estimated value when the result is less than the specified detection limit.

(d) NS Not spiked.

**TABLE 3.30. Sediment Polychlorinated Dibenzodioxin (PCDD) and Dibenzofuran (PCDF)
Results for Sediment Composite RM 119.56**

<u>Analyte</u>	<u>Dioxins(ng/kg dry weight)</u> <u>Sediment Composite RM 119.56 V(a)</u>
<u>Chlorinated Dioxins</u>	
2378-TCDD	1.50 U ^(b)
Total TCDD	3.30
12378-PeCDD	0.67 U
Total PeCDD	ND ^(c)
123478-HxCDD	1.30 U
123678-HxCDD	2.00 U
123789-HxCDD	1.40 U
Total HxCDD	15.00
1234678-HpCDD	14.00
Total HpCDD	28.00
OCDD	98.00
<u>Chlorinated Furans</u>	
2378-TCDF	5.6
Total TCDF	14.00
12378-PeCDF	0.76 U
23478-PeCDF	0.42
Total PeCDF	1.70
123478-HxCDF	0.30 U
123678-HxCDF	0.13
123789-HxCDF	0.93
234678-HxCDF	0.23 U
Total HxCDF	3.90
1234678-HpCDF	2.50
1234789-HpCDF	0.52 U
Total HpCDF	2.80
OCDF	5.70

(a) V Sampled with a Van Veen grab.

(b) U The analyte was not present above the level of the associated value.

(c) ND Not detected

TABLE 3.31. Internal Standards for Polychlorinated Dibenzodioxins (PCDD) and Dibenzofurans (PCDF)

<u>Analyte</u>	<u>Dioxins (percent dry weight)</u>
	<u>Sediment Composite RM 119.56 V^(a)</u>
2378-TCDD-C13	88
12378-PeCDD-C13	133
123478-HxCDD-C13	42
123678-HxCDD-C13	27
1234678-HpCD-C13	81
OCDD-C13	79
2378-TCDF-C13	79
12378-PeCDF-C13	100
23478-PeCDF-C13	130
123478-HxCDF-C13	99
123678-HxCDF-C13	93
123789-HxCDF-C13	81
234678-HxCDF-C13	81
1234678-HpCDF-C13	73
1234789-HpCDF-C13	74
<u>Enrichment Efficiency Standard</u>	
2378-TCDD-C13	87

(a) V Sampled with a Van Veen grab.

TABLE 3.32. Quality Control Data for Polychlorinated Dibenzodioxin (PCDD) and Dibenzofurans (PCDF)

Percent Analyte	Dioxins (pptr dry weight)									
	Method Blank Recovery			Matrix Spike			Matrix Spike Duplicate			
	Spiked	Recovered	Percent Recovery	Spiked	Recovered	Percent Recovery	Spiked	Recovered	Percent Recovery	RPD
<u>Chlorinated Dioxins</u>										
2378-TCDD	17.70	18.58	105	41.67	45.83	110	44.44	48.89	110	0
Total TCDD	17.70	18.58	105	41.67	45.83	110	44.44	48.89	110	0
12378-PeCDD	88.50	97.35	110	208.33	208.33	100	222.22	206.67	93	7
Total PeCDD	88.50	97.35	110	208.33	208.33	100	222.22	206.67	93	7
123478-HxCDD	88.50	106.20	120	208.33	229.17	110	222.22	244.44	110	0
123678-HxCDD	88.50	97.35	110	208.33	208.33	100	222.22	222.22	100	0
123789-HxCDD	88.50	97.35	110	208.33	250.00	120	222.22	266.67	120	0
Total HxCDD	265.49	300.88	113	625.00	687.50	110	666.67	733.33	110	0
1234678-HpCDD	88.50	97.35	110	208.33	208.33	100	222.22	244.44	110	10
Total HpCDD	88.50	97.35	110	208.33	208.33	100	222.22	244.44	110	10
OCDD	176.99	185.84	105	416.67	458.33	110	444.44	511.11	115	4
<u>Chlorinated Furans</u>										
2378-TCDF	17.70	20.35	115	41.67	45.83	110	44.44	48.89	110	0
Total TCDF	17.70	20.35	115	41.67	45.83	110	44.44	48.89	110	0
12378-PeCDF	88.50	97.35	110	208.33	229.17	110	222.22	222.22	100	10
234678-PeCDF	88.50	97.35	110	208.33	229.17	110	222.22	244.44	110	0
Total PeCDF	176.99	194.69	110	416.67	458.33	110	444.44	466.67	105	5

3.51

4.0 DISCUSSION AND CONCLUSIONS

Sediments collected from the Snake and Columbia rivers collected during this study were analyzed for conventional parameters (grain size, TOC, ammonia, phosphate, sulfide, and oil and grease), metals (As, Cd, Cr, Cu, Pb and Zn), PAHs (16 compounds), PCBs (4 Compounds), chlorinated pesticides (18 Compounds), and chlorinated dioxins and furans. The following discussion and conclusions focus on 1) comparison of sediment chemistry characteristics from the Snake River Ports of Wilma, Clarkston, Lewiston and Almota with the sediment chemistry characteristics of the proposed disposal site at RM 119.56; 2) sediment chemistry characteristics from some areas on the Snake River within Lower Granite Reservoir that could experience resuspension of sediment as a result of reservoir drawdown; and 3) sediment chemistry characteristics of the lower Snake River Port of Burbank and Columbia River ports and terminals of Kennewick, Walla Walla, Sheffler, and Boise Cascade. The sediment chemistry characteristics of the lower Snake River and Columbia River ports and terminals are not compared to sediments from an in-water disposal site because at the time of the study, they were scheduled for disposal at an uplands site.

4.1 COMPARISON OF SEDIMENTS FROM PORTS OF WILMA, CLARKSTON, LEWISTON, AND ALMOTA WITH PROPOSED SNAKE RIVER DISPOSAL SITE SEDIMENTS

A summary of sediment chemistry characteristics of the Ports of Wilma (SRP 14 through 22), Clarkston (SRP 24,25 and SRP 26,27), Lewiston (SRP 28,29, SRP 30 through 32, and SRP 33,34), Almota (SRP 55,56), and the proposed disposal site at RM 119.56 is provided in Table 4.1. Only those chemical parameters that were found above the detection limit in at least one sediment composite are shown. In the following sections the sediment chemistry characteristics of the ports are compared to those of the proposed disposal site using the guidelines provided in "General Decisionmaking Framework for Management of Dredged Material" (Lee 1991). This document states that "The determination of a critical level of contamination above the reference and/or background should be made on a site-by-site basis and will depend on the administrative goal established for the disposal site such as maintaining nondegradation, achieving cleaner conditions, or returning to background conditions. Under some circumstances, contamination factors of 1.5 above reference have been proposed as an acceptable approach." For the purpose of this discussion, the chemical composition of sediments from the ports will be considered significantly elevated if they are greater than 1.5 times the concentrations in sediment from the proposed disposal site.

TABLE 4.1. Summary of Conventional, Oil and Grease, Metals, and Organics for the Snake River Sampling Composites Which Were Compared to RM 119.56. (Values 1.5 Times Greater Than RM 119.56 are Bolded).

Disposal Parameter	Proposed Disposal Site RM 119.56	Port of Wilma SRP 14 - 22	Port of Clarkston SRP 24.25	Port of Clarkston SRP 26.27	Port of Lewiston SRP 28.29	Port of Lewiston SRP 30 - 32	Port of Lewiston SRP 33.34	Port of Almota SRP 55.56
Grain size (% fine)	81	18	19	41	18	8	3	4
TOC (%)	3.12	1.5	1.1	2.6	0.4	0.3	0.6	0.16
NH3-(mgN/kg)	NA (a)	14.1	21.7	34.1	1.6	7.2	6.4	0.1
PO4-(mgP/kg)	NA	0.1	0.15	0.03	<0.01	0.04	0.04	0.16
Sulfide (mg/kg)	NA	9.1	55	82.8	<1.7	0.9	0.9	<0.5
Oil and grease	1095	63	85	106	15	35	16	14 U(b)
Metals (mg/kg)								
As	6.14	4.4	3.3	4.5	1.4	1.1	1.3	3.29
Cd	0.3 U	0.2 U	0.2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Cr	19.8	18.2	13.3	15.2	11.6	6.6	7.2	13.1
Cu	31.1	23.8	24.0	27.0	13.1	8.4	6.9	9.6
Pb	13.7	7.6	6.7	9.5	3.8	2.5	3.0	4.1
Zn	71.6	55.8	49.3	58.2	30.5	29.1	26.0	37.4
Organics (ug/kg)								
Acenaphthene	1.2 U	27 U	1.7 J(c)	1.4 U	1.2 U	2.8	13 U	1.3 U
Fluorene	2.2	27 U	2.5	1.6	1.2 U	2.7	13 U	1.3 U
Phenanthrene	7.8	27 U	6.9	6	1.2 U	8.6	13 U	1.3 U
Anthracene	1.2	27 U	2.6	1.9	1.2 U	1.2	13 U	1.3 U
Fluoranthene	8.4	27 U	1.4	4.7	1.2 U	10	18	1.3 U
Pyrene	5.8	27 U	7.1	3.2	1.2 U	6.3	22	1.3 U
Benzo(a)anthracene	2.7	27 U	4.4	1.4 U	1.2 U	1.3	22	1.3 U
Chrysene	5.5	27 U	6.1	1.8	1.2 U	2.8	30	1.3 U
Benzo(k)fluoranthene	8.7	27 U	9.8	3.3	1.2 U	3.7	70	1.3 U
Benzo(a)pyrene	3.3	27 U	4.6	1.4 U	1.2 U	1.6	49	1.3 U
Aroclor 1260	5.1 J (c)	10 U	10 U	20 U	10 U	10 U	10 U	10 U
4,4'-DDD	1.3 U	1.3 J	1 J	1 J	2 U	0.7 J	2 J	2 U
4,4'-DDE	6.8 J	2.8 J	0.6 J	3.3 J	2 U	1.7 J	1 J	2 U
4,4'-DDT	0.4 J	0.6 J	1.2 J	2 U	2 U	2 U	2 U	2 U
2,3,7,8-TCDD (pptr)	1.5 U	0.25	0.05	0.20	0.02	0.20	0.20	0.06
2,3,7,8-TCDF (pptr)	5.6	1.28	0.34	0.06	0.14	0.06	0.06	0.38

(a) NA Not applicable.

(b) U Analyte not present above the level of the associated value.

(c) J Estimated value below the method detection limit.

4.1.1 Port of Wilma (SRP 14-22)

The Port of Wilma, shown in Figure 1.8, is located about 15 river miles upstream of the proposed disposal site at RM 119.56. One sediment composite consisting of nine sediment sampling stations (Table 2.1) was analyzed for the stated chemical parameters. The sediment composite consisted primarily of silty sand with gravel having less than 20% silt and clay. None of the measured chemical parameters in the Port of Wilma composite exceeded those of the proposed disposal site at RM 119.56.

4.1.2 Port of Clarkston (SRP 24,25 and SRP 26,27)

The Port of Clarkston, shown in Figure 1.9, is located about 18 river miles upstream of the proposed disposal site at RM 119.56. Two sediment composites consisting of two sampling stations each (Table 2.1) were analyzed for the stated chemical parameters. The sediment was composed of a silty sand with the silt and clay content of the two composites varying from about 20% to 40%. Metals, PCBs, chlorinated pesticides, and chlorinated dioxins and furans in the two sediment composites from the Port of Clarkston were all lower than those found in the sediment of the proposed disposal site at RM 119.56. All PAH compounds in sediment composite SRP 24, 25, except phenanthrene, were found to be higher than those at the proposed disposal site. The PAH compounds, anthracene, fluoranthene and benzo(a)anthracene, were found at concentrations exceeding 1.5 times the concentrations at the proposed disposal site. Only the PAH compound anthracene in sediment composite SRP 26,27 exceeded that at the proposed disposal site, but was less than 1.5 times higher.

4.1.3 Port of Lewiston (SRP 28,29, SRP 30-32, SRP 33,34)

The Port of Lewiston, shown in Figure 1.9, is located about 19 river miles upstream of the proposed disposal site at RM 119.56. Three sediment composites consisting of sampling stations at the port (Table 2.1) were analyzed for the stated chemical parameters. The sediment consisted of silty sand with gravel to sand having less than 20% silt and clay. None of the measured metals, PCBs, chlorinated pesticides, and chlorinated dioxins and furans from these Port of Lewiston sediment composites exceeded the concentrations in sediment from the proposed disposal site at RM 119.56. Polynuclear aromatic hydrocarbons in sediment composite SRP 28,29 were below the method detection level. At SRP 30-32, the PAH compound acenaphthene was greater than 1.5 times the concentration at the proposed disposal site. Six PAH compounds in sediment composite SRP 33,34 were greater than 1.5 times the concentrations at the proposed disposal site. These six PAH compounds included fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(k)fluoranthene, and benzo(a)pyrene.

4.1.4 Port of Almota (SRP 55.56)

The Port of Almota, shown in Figure 1.7, is located about 16 river miles downstream of the proposed disposal site at RM 119.56. One sediment composite consisting of two sampling stations (Table 2.1) was analyzed for the stated chemical parameters. The sediment consisted almost exclusively of sand with less than 5% silt and clay. None of the measured chemical parameters in the sediment composite from the Port of Almota exceeded concentrations in sediment from the proposed disposal site at RM 119.56.

4.2 SEDIMENT CHEMISTRY CHARACTERISTICS OF LOWER GRANITE RESERVOIR COMPOSITES SRP 12, SRP 13, SRP 23, SRP 52, SRP 53, and SRP 54

A summary of sediment chemistry characteristics of those sampled areas on the Snake River that could experience resuspension of sediment as a result of reservoir drawdown is provided in Table 4.2. All these RM sediment composites were located in the Lower Granite Reservoir. The locations of the stations are shown in Figures 1.10 and 1.11. The RM sediment composites were compared to the proposed disposal site of RM 119.56 only because of the geographical proximity of these composites to the proposed disposal site. These RM composites were not scheduled for dredging but were samples to evaluate the potential resuspension of these fine sediments as a result of the drawdown. The sediments were all fine grained with greater than 60% silt and clay. With the exception of Cd, metals concentrations were detectable in all the RM sediment composites. Of the RM composites, the highest metals concentrations were found at SRP 23, located about 7 miles downstream of Clarkston near Silcott Island. Arsenic, Cr, and Cu concentrations in the SRP 23 composite were the highest of all sediments analyzed in this study. These high metals concentrations could be associated with the relatively fine-grained nature and high TOC content of the sediments. Metals levels in other RM stations also were relatively high and consistent with the metals levels found at the proposed disposal site at RM 119.56, which also may be associated with the fine-grained nature and higher TOC content of the sediment at the RM stations.

Relatively high PAH levels were found in sediment composites at the RM stations in Lower Granite Reservoir. These PAH levels were consistent with the levels found in sediments of the proposed disposal site at RM 119.56 and are probably associated with the fine-grained nature and higher TOC content of the sediments. Of the RM stations in Lower Granite Reservoir, sediment composite SRP 12, located about 16 miles downstream of Clarkston had the highest PAH compound concentrations of fluorene, phenanthrene, fluoranthene, pyrene, benzo(k)fluoranthene and benzo(a)pyrene. Port of Clarkston and/or Port of Lewiston sediment composites generally had higher levels of these PAH compounds. The highest anthracene

TABLE 4.2. Summary of Conventional, Oil and Grease, Metals, and Organics for RM Sampling Composites.

Parameter	RM Composites					
	SRP 12	SRP 13	SRP 23	SRP 52	SRP 53	SRP 54
Grain Size(% fine)	91	71	60	70	74	81
TOC (%)	0.6	5.33	2.7	4.3	2.8	2.93.9
NH3-(mgN/kg)	18.8	20.1	20.1	4.3	4.8	4.0
PO4-(mgP/kg)	0.12	0.22	0.04	0.06	0.06	0.17
Sulfide (mg/kg)	64.2	145.4	67.2	62.4	62.4	105.2
Oil and grease	209	100	195	118	175	179
<u>Metals (mg/kg)</u>						
As	9.5	5.2	9.6	5.4	7.3	7.5
Cd	0.2 U	0.2 U	0.2 U	0.3 U	0.4 U	0.3 U
Cr	9.3	20.8	23.4	16.2	21.6	21.4
Cu	35.2	33.3	38.8	22.2	34.7	36.3
Pb	8.4	10.6	16.3	9.5	14.2	15.6
Zn	67.8	68.5	78.7	56.8	78.4	76.9
<u>Organics (ug/kg)</u>						
Acenaphthene	2.1 U	33 U	1.8 U	1.6 U	1.8 U	1.9 U
Fluorene	2.7	33 U	1.8	2.5	1.8 U	1.9 U
Phenanthrene	7.5	33 U	5	7.1	3.1	3.4
Anthracene	2.1 U	33 U	1.7	11	1.8 U	1.9 U
Fluoranthene	7.2	33 U	4.9	5.5	4.3	5.4
Pyrene	7.4	33 U	4.7	4.6	2.9	4.0
Benzo(a)anthracene	2.6	33 U	2.8	1.6	2.0 U	2.2
Chrysene	4.9	33 U	5.6	3.4	3.0	3.4
Benzo(k)fluoranthene	7.7	33 U	5.8	4.9	4.8	6.4
Benzo(a)pyrene	3.3	33 U	2.2	2.1	2.1	3.1

TABLE 4.2. (contd)

Parameter	FM Composites					
	SRP 12	SRP 13	SRP 23	SRP 52	SRP 53	SRP 54
Aroclor 1260	10 U	10 U	10 U	10 U	10 U	10 U
4,4'-DDD	2.3	0.9 J	0.9 J	4.5 J	1.2	1.2
4,4'-DDE	9.6	5.1 J	3.4 J	16 J	6.5	7.4
4,4'-DDT	1.1 J	2 U	2 U	3.6 J	2 U	2 U
2,3,7,8-TCDD	0.32	0.09	0.20	0.34	0.44	0.50
2,3,7,8-TCDF	1.01	0.51	0.44	3.92	4.46	4.78

(a) NA Not applicable.

(b) U Analyte not present above the level of the associated value.

(c) J Estimated value below the method detection limit.

concentration at RM stations was found in SRP 52, and the highest benzo(a)anthracene and chrysene concentrations were found at SRP 23. All PAH compounds were below the detection limits in SRP 13, which is located about 11 miles downstream of Clarkston.

Polychlorinated biphenyls in sediments of the RM stations were undetected, which is consistent with PCBs in sediment of the proposed disposal site at RM 119.56 and ports on the Snake River. Detectable levels of the chlorinated pesticides 4,4'-DDD and 4,4'-DDE were found in sediments at SRP 12, SRP 53, and SRP 54. Chlorinated dioxins and furans (2,3,7,8-TCDD and 2,3,7,8-TCDF) were found at detectable levels in sediments of all the RM stations and were consistent with the levels found in sediment at the Snake River ports and the proposed the disposal site at RM 119.56.

4.3 SEDIMENT CHEMISTRY CHARACTERISTICS AT THE PORTS OF BURBANK AND KENNEWICK, AND TERMINALS OF SHEFFLER GRAIN, WALLA WALLA, AND BOISE CASCADE

A summary of sediment chemistry characteristics of the Port of Burbank (SRP 7A), Port of Kennewick (SRP 3,4), Sheffler Grain Terminal (SRP 9), Walla Walla Grain Terminal (SRP 1,2) and Boise Cascade (SRP 50, SRP 51) is provided in Table 4.3. The Port of Kennewick sediment composite (SRP 3,4) had the highest concentrations of five of the six metals measured in sediment composites of the lower Snake River and Columbia River ports and terminals. Only As was found at higher concentrations in the Port of Burbank sediment composite (SRP 7A). Cadmium, Pb, and Zn levels were especially enriched in the Port of Kennewick sediment composite compared to the other lower Snake River and Columbia River ports and terminals. The Port of Kennewick sediment composite also had the highest concentrations of nine PAH compounds, which, except for fluorene and phenanthrene at the Sheffler Grain Terminal, were undetected at the other lower Snake River and Columbia River ports and terminals.

The relatively high levels of Cd, Pb, Zn, and PAHs in the Port of Kennewick sediment composite are most likely due to nearby industrial activity or urban runoff. The ratio of Cd to Zn concentrations in the sediments of the Port of Kennewick are about the same as the ratio found in the construction of zinc alloys used in die casting for the automotive industry, and manufacture of cameras, business machines, appliances, toys, etc., strongly suggesting that these types of activities in the immediate vicinity of the Port of Kennewick have contributed to the levels of Cd and Zn in the sediments. Additionally, the ratio of Zn to Pb found in the same sediment composite is similar to that found in battery plates.

TABLE 4.3. Summary of Conventional, Oil and Grease, Metals, and Organics for the Lower Snake and Columbia River Composites

Parameter	Walla Walla Grain Terminal SRP 1.2	Port of Kennewick SRP 3.4	Port of Burbank SRP 7A	Sheffler Grain Terminal SRP 9	Boise Cascade Mill SRP 50	Boise Cascade Mill SRP 51
Grain Size(% fine)	41	14	37	NA	38	57
TOC (%)	0.55	0.56	0.63	NA(a)		0.3
NH3-(mgN/kg)	12.6	15.1	35.1	NA	6.0	13.1
PO4-(mgP/kg)	0.07	0.06	0.23	NA	0.08	0.04
Sulfide (mg/kg)	5.5	7.7	8.4	NA	<1.2	<1.2
Oil and grease	28	14	27	13 U(b)	32	43
<u>Metals (mg/kg)</u>						
As	3.1	3.1	5.7	4.5	3.6	2.8
Cd	0.2	1.6	0.2 U	0.2 U	0.2	0.2 U
Cr	14.3	20.1	16.3	11.8	15.2	11.3
Cu	15.5	20.2	17.2	18.4	15.2	18.1
Pb	7.7	20.8	7.1	7.8	6.5	6.0
Zn	62.6	277	51.5	51.0	52.2	57.5
<u>Organics (ug/kg)</u>						
Acenaphthene	12 U	21	13 U	2.2 U	13 U	12 U
Fluorene	12 U	18	13 U	1.3	13 U	12 U
Phenanthrene	12 U	57	13 U	1.3	13 U	12 U
Anthracene	12 U	15	13 U	1.3 U	13 U	12 U
Fluoranthene	12 U	42	13 U	1.3 U	13 U	12 U
Pyrene	12 U	33	13 U	1.3 U	13 U	12 U
Benzo(a)anthracene	12 U	13 U	13 U	1.3 U	13 U	12 U
Chrysene	12 U	19	13 U	1.3 U	13 U	12 U
Benzo(k)fluoranthene	12 U	23	13 U	1.3 U	13 U	12 U
Benzo(a)pyrene	1.1 U	13	13 U	1.3 U	13 U	12 U

TABLE 4.3. (contd)

Parameter	Walla Walla Grain Terminal SRP 1.2	Port of Kennewick SRP 3.4	Port of Burbank SRP 7A	Sheffler Grain Terminal SRP 9	Boise Cascade Mill SRP 50	Boise Cascade Mill SRP 51
Aroclor 1260	5.6 J(c)	10 U	10 U	10 U	11	6.5
4,4'-DDD	0.7 J	1.7 J	0.6 J	2 U	0.4 J	0.5 J
4,4'-DDE	2.4	1.3 J	0.7 J	2 U	0.8 J	2 U
4,4'-DDT	2.0 U	0.5 J	2 U	2 U	2 U	2 U
2,3,7,8-TCDD (pptr)	0.30	0.18	0.09	0.47	0.47	0.62
2,3,7,8-TCDF (pptr)	7.72	0.44	0.20	2.59	12.10	15.5

(a) NA Not applicable.

(b) U Analyte not present above the level of the associated value.

(c) J Estimated value below the method detection limit.

The two Boise Cascade sediment composites (SRP 50 and SRP 51) were the only samples with detectable levels of PCBs (Aroclor 1260). In addition, the Boise Cascade sediment composites had the highest levels of chlorinated dioxins and furans. Sediment composite SRP 51 had a 2,3,7,8-TCDD concentration of 0.62 ppb and a 2,3,7,8-TCDF concentration of 15.5 ppb. These higher levels of chlorinated dioxins and furans in the sediments at Boise Cascade indicate a potential nearby source. Except for 4,4'-DDE at the Walla Walla Grain Terminal (SRP 1,2), chlorinated pesticides were undetected in the sediment composites from the lower Snake River and Columbia River ports and terminals.

4.4 CONCLUSIONS

4.4.1 Snake River Ports

Comparison of sediment from the Snake River Ports of Wilma, Clarkston, Lewiston and Almota with sediments from the proposed disposal site RM 119.56 provides an indication of the suitability of sediments from these ports for disposal at an in-water disposal site at RM 119.56. Sediments from the Ports of Wilma and Almota met the 1.5 times evaluation criterion for in-water disposal at RM 119.56 for all metals, PAHs, PCBs, chlorinated pesticides, and chlorinated dioxins and furans.

The Ports of Clarkston and Lewiston met the 1.5 times evaluation criterion for in-water disposal at RM 119.56 for all metals, PCBs, chlorinated pesticides, and chlorinated dioxins and furans, but did not meet the evaluation criterion for some PAH compounds. The PAH compounds acenaphthene, fluoranthene, and benzo(a)pyrene concentrations in the Port of Clarkston sediment composite SRP 24,25 exceeded the concentrations at the proposed disposal site by more than 1.5 times. The PAH compound, acenaphthene, in the Port of Lewiston sediment composite SRP 30-32 exceeded the concentration at the proposed disposal site by more than 1.5 times. The PAH compounds fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(k)fluoranthene, and benzo(a)pyrene, in the Port of Lewiston sediment composite SRP 33,34 exceeded concentrations at the proposed disposal site by more than 1.5 times. These PAH compounds at SRP 33,34 were found at the highest levels of all samples analyzed during this study, generally from 2 to 10 times higher than the proposed disposal site and any other ports. Based on the relatively high PAH levels in some sediments of the Ports of Clarkston and Lewiston found in this study, additional chemical and toxicological evaluations may be necessary to demonstrate that the PAH levels in these sediments do not have an adverse biological impact before in-water, unconfined disposal at the proposed disposal site at RM 119.56 could occur. However, if an alternative disposal option such as capping the sediments from the Ports of Clarkston and Lewiston with clean sediment is employed, then further testing might not be necessary.

4.4.2 Fine Sediments From Lower Granite Reservoir

Sediment samples were collected in the Lower Granite Reservoir in areas where river drawdown could potentially expose fine sediments to resuspension by current, wave, or precipitation action. Fine-grained sediments with relatively high TOC content were selected for sampling because these types of sediments would be expected to have higher levels of potential contaminants. Although biological criteria were not used in this study to evaluate the potential biological effects of resuspending these fine-grained sediments as a result of river drawdown, an indication of potential biological effects can be discussed by comparing the relative concentrations of chemical constituents within these sediments. These evaluations would need to be substantiated with actual toxicological testing.

Six RM sediment composites were collected and analyzed for metals, PAHs, PCBs, chlorinated pesticides, and chlorinated dioxins and furans from the Lower Granite Reservoir. Some of the highest levels of metals were found in the sediments of these RM stations. The highest As, Cr, and Cu concentrations were found at SRP 23, and Pb and Zn concentrations were exceeded only at the Port of Kennewick.

Some PAH compounds in sediments from the RM stations were also found at relatively high levels when compared to other Snake and Columbia river samples. The only other locations that had consistently higher PAH levels were the Port of Kennewick on the Columbia River and one sediment composite from the Port of Lewiston (SRP 33,34) on the Snake River. The PAH concentrations in sediments from the RM stations were fairly consistent, except for SRP 13, which had no detectable concentrations of any of the PAH compounds. The relatively consistent concentrations in the RM stations suggest an upstream source, and affinity of these fine grained, high TOC content sediments for PAH compounds. Polychlorinated biphenyls were not found at detectable levels in the fine sediments of Lower Granite Reservoir, and as a result are assumed to be of little concern biologically if sediments are resuspended during reservoir drawdown.

Relatively high chlorinated pesticide concentrations were found in some fine sediments in Lower Granite Reservoir collected in this study. The highest levels of 4,4'-DDD and 4,4'-DDE were found in sediment composites SRP 12, SRP 53, and SRP 54. The source of these high chlorinated pesticide levels is unknown, but could be associated with residuals from past agricultural practices in the region.

Relatively high chlorinated dioxin and furan concentrations (2,3,7,8-TCDD and 2,3,7,8-TCDF) were found in the fine sediments of Lower Granite Reservoir collected in this study. The concentrations of 2,3,7,8-TCDF within sediments of the RM stations were relatively consistent and were exceeded only in Boise Cascade sediment composites (SRP 50 and SRP 51), Walla Walla Grain Terminal, and the proposed disposal site.

4.4.3 Lower Snake and Columbia River Ports and Terminals

As part of this study, sediment samples were collected and sediment chemistry characteristics were evaluated for the Ports of Burbank and Kennewick, and terminals of Sheffler Grain, Walla Walla, and Boise Cascade. Access to these lower Snake River and Columbia River ports and terminals could potentially be affected by drawdown, and although dredged material from deepening the channels would probably be disposed of at an uplands site, an evaluation of the sediment chemistry characteristics was made as part of this study.

The sediments from Port of Kennewick had the highest levels of most metals and PAHs of the lower Snake River and Columbia River ports and terminals sampled during this study.

Sediments from Boise Cascade had the only detectable levels of the PCB congener, Aroclor 1260. One sediment composite from Boise Cascade (SRP 51) also had the highest levels of the chlorinated dioxins and furans of any of the sediments analyzed in this study. The Walla Walla Grain Terminal had a relatively high level of the chlorinated pesticide, 4,4'-DDE in comparison to the other ports and terminals, but was generally lower than the concentrations found in fine sediment of the Lower Granite Reservoir. Chlorinated pesticides concentrations in sediments of the other ports and terminals were either undetected or had estimated values below the method detection limits. Sediments from the Port of Burbank had undetected or very low concentrations of all metals (except As), PAHs, PCBs, chlorinated pesticides, and chlorinated dioxins and furans relative to the other ports and terminals. The As level in sediment from the Port of Burbank was higher than the Columbia River ports and terminals, but was consistent with concentrations found in fine sediment of Lower Granite Reservoir and the proposed disposal site at RM 119.56. Sediments from the Sheffler Grain Terminal had undetected or low concentrations of all the measured chemical parameters when compared to other lower Snake River and Columbia River ports and terminals.

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